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Reflections.

We found it somewhat difficult to think of suitable material for this issue during what proved to be one of the most summerlike and hot test spells we have experienced in this country for some time; probably our readers will find it equally as difficult to find sufficient energy to peruse it if the hot heat continues. We were attracted, for instance, by the announcement of a brewery in Czecho-Slovakia, that it would pay a dividend in beer, each shareholder receiving some twenty gallons. It is well known, of course, that while there is no bad beer, just as there is no bad iron, quite definitely beer made in Central Europe is beer. We were proposing to extend this idea and explore the possibility of foundries paying their dividends in chilled rolls, or liners, when we noticed a Sunday contemporary pointing out that a dividend could be scarcely paid, for instance, in cast-iron drain pipes. Doubtless a shareholder paid with a small section of a chilled roll would give it a reception as chilly as the roll.

Then there is Lausanne. The only enthusiasm we could raise over this would not effervesce until we felt sure that all the money we had agreed to forego would not be paid to America. We thought, with a sigh, that Britain always was the little gentleman. But why should we pass on anything when there is nothing to pass on?

The Import Duties Advisory Committee has issued a list of machinery which, on application, may be admitted tax-free. And we reflected how much the foundry industry in all its branches is dependent on the machine industry for much of its success. If we have to buy foreign machines we are compelled, whether we like it or not, to buy foreign castings.

Finally, we thought of that memorandum, recently circulated confidentially by the British Standards Institution, and on which we are not yet in a position to comment, emanating from the British Chamber of Commerce at Buenos Aires, and asking whether British engineering products are not too good for the job they are rated to perform. The robustness, solidity and general excellence of British design is paid for usually in lengthened delivery time and extra transport costs due to the extra weight. This memorandum has come at the psychological moment and is attracting a lot of attention. And founders will have more to say than anybody if they are called on to respond in the required direction, because much of the weight lies in the casting. Can it be cut down? If it can be trimmed it will be worth an actual increase in cost to the British export trade. We shall hope to return to this subject when the whole matter has got beyond the confidential stage.

Steel Founding at the Cross Roads.

Steel-foundry owners have recently received a circular asking them whether they would be prepared to negotiate for the sale of that part of their plant devoted to the manufacture of steel castings, as a movement is on foot to buy and dismantle a limited number of establishments, with a view to ridding the industry of its excess capacity. For current trading conditions, it is admitted on all sides that a serious excess does exist, and it is impossible for the industry to flourish so long as its individual members make such frantic, yet abortive, efforts to maintain production at a level designed to take care of overhead expenses; such efforts obviously depress prices below an economic level. Naturally an internecine war of attrition would eventually effect the same result, but it would carry in its train a path of misery. This scheme, which is modelled after the one devised for the shipbuilding industry, offers an opportunity for the steel-foundry owner to retire graciously from the lists with honour and cessation of monetary losses. If the scheme is successful, we hope the General Steel Casting Association will then have time to study other questions for their mutual good. *Inter alia*, whilst many of the larger concerns conduct large private research departments, they would be well advised to create a co-operate organisation in their endeavours. Such an organisation is appreciated by government departments, including tariff commissions, as evidence that the industry as an industry is making a serious effort to give service to the public.

This age, to quote an erudite American professor, is characterised by the interdependence of nations, and commercial co-operation should be instituted internationally. Yet even before this liaison is created, contact should be established with other organised branches of founding, both industrial and scientific. The problems associated with sand are more acute when making steel castings, that in other branches of the industry. Whilst obviously the steel founding industry is cognisant of the results achieved and utilises regularly systems of control, it has only contributed its quota through individual members and not as a unified industry.

A careful watch will have to be made on all new developments, as omissions to adopt, say, a new type of furnace is ample incentive for the financing of a new steel foundry. The prospectus has only to be worded that steel can be produced 25 per cent. cheaper than existing processes, and the investing public will assume a highly-specialised selling organisation, a skilled staff of moulders, metallurgists and other trained individuals, associated with an adequate supply of all the other essentials, to part with their savings. We offer no apology for preaching to a committee of business men of established reputation for acumen, because we have found that the ambit of vision of many employers' associations, is myopic, owing no doubt to over-concentration on too few topics.

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XUM

High-Test Cast Iron in the United States of America.*

By R. S. Macpherran.†

The purpose of this Paper is to give a short description of the present status of high-test cast iron in the U.S.A. It is practically impossible in one article to list every phase of this product or to discuss all the various applications in the many companies using it. In place, therefore, of a general description covering to a limited extent all conditions it was considered more satisfactory to give a few specific and typical cases where this iron is being successfully used. There is no standard quality for high-test iron and no specifications covering recent developments. Various foundries adopt the material and practice best suited to their own needs. The subject is a very live one with constant change and improvement. Any Paper written at this time (January, 1932) may not contain all the latest developments in effect at the time it is presented.

MR. R. S. MACPHERRAN.

There has been in the past few years a marked tendency toward specialisation. One foundry will specialise in automobile heads and cylinders, a second in pistons or rings, a third perhaps in brake-drums, etc. This specialisation has been assisted by two factors. First, the great production demand of the automobile industry, and second, the development of the electric furnace. Of this latter it is estimated that over 80 have been installed in this country for the production of commercial iron-castings. This estimate was reported by Mr. W. B. Wallis, Pittsburgh Electric Furnace Corporation. In describing these processes no attempt will be made to go into the theory of high-test iron, and as far as possible statements will be confined to actual experience and results.

Definition of High-Test Iron.

In discussing this subject a field must first be defined which covers high-test cast iron as a part from the irons of lower strength. For the purpose of this article it was decided to include under this heading only those irons breaking higher than 20 tons tensile strength per sq. in., and that this test should have been made as far as possible on test specimen machined from the old standard A.S.T.M. arbitration test-bars. These bars were cast 1¼ in. round in dry sand or cores and are broken transversely between 12-in. supports. Unless otherwise stated tensile-specimens were machined from the broken transverse bars in accordance with the sketch, Fig. 6.

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(1A).

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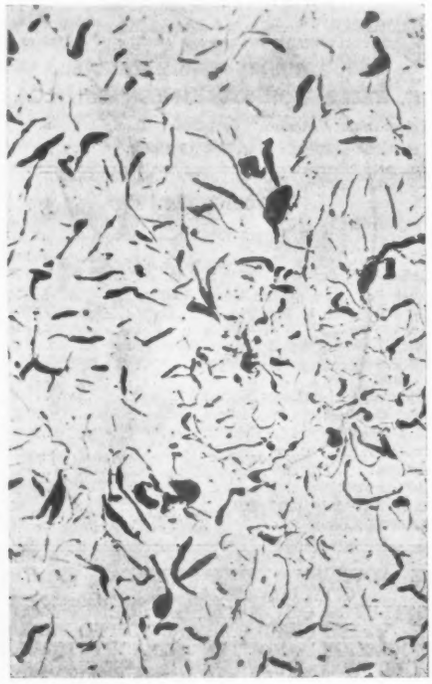

(1B).

FIGS. 1A AND 1B.—ELECTRIC-FURNACE IRON: 24 TONS TENSILE AND 248 BRINELL. T.C., 3.02; SI, 2.36; MN, 0.82; S, 0.059; NI, 0.44; CR, 0.37, AND MO, 0.58 PER CENT.

Processes Used.—In general high-test iron is made by one of the following processes:—(*a*) Electric furnace (with or without duplexing from cupola); (*b*) air furnace (with or without duplexing from cupola), and (*c*) cupola.

Electric Furnace Processes.

The electric furnace either melting with an initial cold charge or duplexing with the cupola melting, lends itself especially to the continuous production of small castings, usually automobile, and, therefore, does not always go into the field of highest strengths. This is, of course, for commercial reasons only, as this process can be adapted to any kind of iron desired. The details of this operation and the results therefrom are very well shown in the recent Papers on this subject read before the American Foundrymen's Association and other organisations and will not be described here in great detail.

Automobile Cylinders and Heads.—One installation using a 3-ton furnace specialises on automobile cylinders and heads. The regular operation is continuous. The iron is melted in a 48-in. cupola and tapped into the electric furnace, thus replacing at regular intervals the iron drawn off for pouring. When work is slack the electric furnace is used to melt from cold charges. A typical cold charge is 7,700 lbs. of cast-iron borings, and 3,000 lbs. of cast-iron scrap, with 2,800 lbs. of baled-sheet steel. When duplexing through the cupola scrap iron comprises the bulk of the charge with between 20 to 30 per cent. of bundled sheet steel added in the electric furnace. In this way is avoided the loss in melting bundled sheet-steel scrap in the cupola and also there is obtained the desired reduction in carbon. The cost of material used in either method is always low. In 1930 the cost to this plant of their iron in the ladle when duplexing was about £6 1s. 4d. per ton. This includes all materials, power, interest, depreciation, and all labour, including that of pouring. When alloy additions are made this cost is, of course, increased.

Recent tests of arbitration test-bars made by this company to represent automobile work show as follow:—

Bar No.	Transverse load in lbs.	Deflection in in.	M.S., tons per sq. in.	Brinell hardness.
1	5,430	0.17	24.0	248
2	4,850	0.15	21.6	241

The analyses of the bars gave:

	Bar No. 1.	Bar No. 2.
T.C.	3.02	2.94
Si	2.36	2.41
Mn	0.82	0.85
S	0.086	0.079
P	0.13	0.17
Ni	0.44	0.50
Cr	0.37	0.31
Mo	0.58	—

Both a high impact value and an additional refinement of grain is claimed for this iron due to the superheating given it in the furnace. The photomicrographs of Fig. 1 are of this iron.

Brake Drums.—A second installation makes brake drums, and a quotation from a letter descriptive of the production reads:—

"We take our cupola iron and put it into Detroit electric furnaces, add sufficient steel to

* Paper presented at Newcastle Conference of the Institute of British Foundrymen.

† Chief chemist, Allis Chalmers Manufacturing Company, West Allis, Wisconsin.

give us a white fracture and proper carbon content and graphitise in the ladle. Brinell specifications on this iron are from 223 to 262. The tensile strength ranges from 22.3 to 26.7 tons per sq. in., and the approximate analyses are as follow:—C.C., 0.50 to 0.70 per cent.; Gr., 1.80 to 2.00; Si, 2.10 to 2.40; Mn, 0.30 to 0.50; S, 0.09 (max.); P, 0.20 (max.); Mo, 0.40 to 0.60 per cent.

"We have had test-bars break as high as 35.7 tons per sq. in. on this iron, but, of course, the average bar does not ordinarily exceed 29.0 tons."

Cam Shafts.—A third company reports on the manufacture of cam shafts for automobile work in the following terms:—

"Electric furnace iron is used. The cam shafts are not heat-treated, but are made with or without a chill as desired. Arbitration test-bars are used (12 in. between supports), and below are typical figures:—

"Transverse strength: 6,000 to 7,500 lbs.

"Tensile strength: 24.5 to 26.7 tons.

"Impact: Over twice that of ordinary cast iron.

"Hardness: Not chilled, 300 Brinell.

"Hardness: Chilled, 600 Brinell.

"Torsion: Equal to that of came-shaft steel.

"Wear: Remarkable wearing qualities.

"Cams running under conditions equivalent to 120,000 miles, at a speed of 90 to 100 miles per hr. show no appreciable wear."

Air Furnace Processes.

There are many installations of the air furnace using either cold stock or with duplexing from a cupola. Here also the grade of iron produced is dependent upon the demand as iron of practically any composition may be made in this manner. In fact, both the electric furnace and air furnace readily tend themselves to the production of low-carbon iron, and low-carbon iron is the prime requisite of high-test iron. Some air furnaces whose main demand has previously been for malleable-iron castings, are now using their excess capacity for making high-test iron.

At least three methods of procedure are now in operation:—(1) Making up the entire heat of a composition suitable for grey-iron castings of high strength; (2) adding ferro-silicon or other graphitisers in the ladle to part of a regular heat of "malleable iron." The remainder of the heat may be used for normal malleable-iron castings if desired; and (3) making the heat of hard iron somewhat the same composition as used for malleable and then heat-treating all castings. In this procedure the castings are usually small and the carbon as cast is combined.

Tensile strengths of 26.7 to 49.1 tons per sq. in. may be so obtained with various elongations up to 15 per cent., depending on the heat-treatment. From the many such treatments in use only two will be described.

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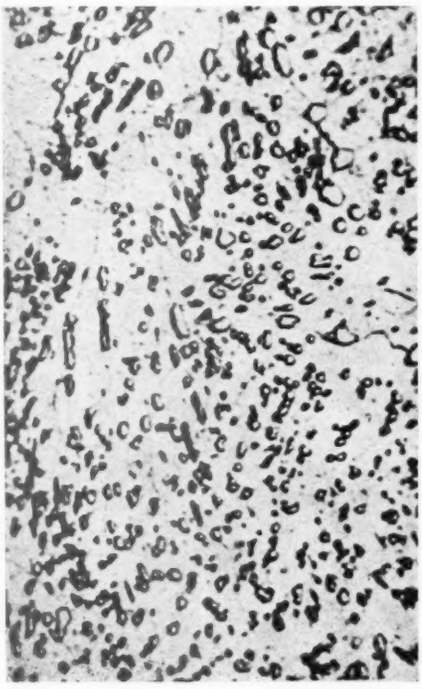

(2A).

(2B).

FIGS. 2A AND 2B.—AIR-FURNACE IRON (SPHERODISED). TENSILE STRENGTH 33 TONS. ELONGATION (2 IN.), 14 PER CENT. REDUCTION OF AREA: 18 PER CENT. BRINELL NO.: 179. COMPOSITION: T.C., 2.29; SI, 1.11; MN, 0.85; S, 0.089, AND P, 0.18 PER CENT.

(*a*) The photomicrographs (Fig. 2) show irons where the castings and test-bars were heated to 926 deg. C. and held at this temperature for 20 hrs., then cooled in air, reheated to just below the critical temperature and held 20 hrs., then cooled in air. A shorter hold would mean a higher strength with less ductility, but with a 20-hr. hold the desired results were obtained. The spheroidisation of the cementite should be noted. The view at 2,000 diameters was taken between carbon spots which appear in the field as in malleable iron.

Features of this iron were:—Carbon, 2.29 per cent.; silicon, 1.11; manganese, 0.85; sulphur, 0.089; phosphorus, 0.18; tensile strength, 33.4 tons per sq. in.; elongation, 14 per cent. in 2 in.; reduction in area, 18 per cent.; Brinell hardness, 179; Rockwell hardness, B90.

(*b*) The photomicrographs (Fig. 3) were from an iron where the test-bar was held at 926 deg. C. for 8 hrs., air-quenched, reheated to 648 deg. C. for 15 min. and oil-quenched. Details of this iron were:—Carbon, 2.34 per cent.; silicon, 1.37; manganese, 0.37; sulphur, 0.08; phosphorus, 0.18 per cent.; tensile strength, 47.8 tons per sq. in.; elongation, 2½ per cent. in 2 in.

No special alloys were used to obtain the above results. All test-bars referred to were A.S.T.M. standard malleable-iron test-bars cast ⅝ in. diameter round and broken in the rough. There was, in all cases, a slight decarburisation on the surface. All analyses, hardness tests and micrographs were taken from the centre of the bar. The first of the above treatments is now in commercial operation under Patent claims. The latter is more or less tentative. There would seem to be a field here for development and one in which the alloys might be of service. The low cost of steel castings, however, may limit this process.

Meehanite.

Reference may be made here to "Meehanite," for which high physical values are claimed. Meehanite cast iron is made in the cupola, electric and air furnace, and involves the use of calcium silicide. The Meehanite process covering the use of basic earth silicides is patented in both this and European countries. When made in the cupola the process makes use of over 75 per cent. steel scrap. By the technique of manufacture and the application of the process of decomposition of excess carbides and controlling the physical constitution of the remaining carbides, metallurgical control is positive. In other words, it is claimed that not only does the process accurately control graphitisation and produce a given graphite content at will, but the form of the graphite is equally well under control no matter the size of section of the casting.

Ermalite.

The metal "Ermalite" should also be mentioned. This also is a patented process which does not require heat-treatment. It is made in an air furnace of the reverberatory type and melted in baths of 50 to 60 tons per melt. Representative physical properties which have been reported are as follow:—

Ultimate strength, tons per sq. in., 23.2 to 29.0.

Per cent. elongation in 2 in., 1 to 2.

Arbitration bar transverse test, 12 in. span, 5,000 to 6,000 lbs.

Total deflection at centre, inches, 0.35 to 0.45.

Brinell hardness ranging between 230 to 240, yet this iron is comparatively easy to machine, being slightly tougher than grey iron.

The average chemical composition of this metal is that of the following analysis:—T.C., 2.40-2.60 per cent.; Gr., 1.60-2.00; C.C., 0.60-0.80; Si, 1.90-2.00; Mn, 0.40-0.45; S, 0.07-0.09; P, 0.15-0.17 per cent.

There are other similar patented processes which could be described, but the above are believed to be sufficiently representative to serve as illustrations.

Cupola Processes.

The practice of adding steel to cupola mixtures is, of course, an old one. As service requirements became more severe, the percentage of steel was increased until in 1913 the author's cupola record shows that a mixture of 60 per cent. steel was in use. The analysis of this iron was, approximately, carbon 3.00 to 3.20; silicon 1, manganese 0.80, sulphur 0.120 and phosphorus 0.30 per cent.; and it was used for castings requiring good wearing surfaces. The standard arbitration test-bars made from this mixture were either white or mottled and as such were not suitable for test. A thicker test-bar would have been very serviceable for this iron. A specimen cut from liners cast 1½ in. thick broke at from 16.9 to 17.8 tons tensile strength per sq. in.

Some few years ago, the germ or nuclei theory of carbon particles became fairly well established. The natural reaction of many foundry-

men therefore was to reduce the number of these nuclei in the iron going into the cupola by reducing the percentage of pig-iron charged and by increasing the percentage of steel. This was first done by running a mixture of nearly all steel with just enough ferro-silicon to make it leave the cupola containing 1 per cent. silicon. By the above procedure it was thought to keep the metal free from graphite nuclei. The iron was then deoxidised and greyed in the ladle by the addition of ferro-silicon, ferro-manganese and shot nickel. The iron produced by this method is close-grained and strong.

This procedure has been modified in the author's foundry by adding most of the ferro-silicon and ferro-manganese in the cupola with only a small amount of ferro-manganese-silicon added in the ladle. The " F " ingot nickel may be added in the cupola or ladle. When added in the ladle, the nickel is preheated to a dull red-

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FIG. 3.—AIR-FURNACE IRON (HARDENED AND TEMPERED) HEATED TO 925 DEG. C. FOR 8 HRS. AND QUENCHED IN AIR; REHEATED TO 650 DEG. C. FOR 15 MIN. AND QUENCHED IN OIL. TENSILE STRENGTH, 47.8 TONS, AND ELONGATION IN 2 IN., 2.5 PER CENT. COMPOSITION: T.C., 2.34; SI, 1.37; MN, 0.37; S, 0.08, AND P, 0.18 PER CENT.

ness before adding to the partly-filled ladle. Personal experience shows the use of nickel shot is to be avoided, especially for large ladles.

When using molybdenum it is added to the stream of iron in the spout in the form of powdered ferro-molybdenum. The alloy used contains 60 to 70 per cent. molybdenum and is readily dissolved by the hot iron. No difficulty has been experienced with its use. The addition of nickel or molybdenum facilitates machining, increases the Brinell hardness, and adds somewhat to the tensile strength. It is personal practice to add 1 per cent. nickel or 0.35 per cent. molybdenum. The 1 per cent. nickel, however, will have more effect on machining properties than the 0.35 per cent. molybdenum. As the cost of molybdenum per lb. is approximately three times that of nickel, the cost per ton of iron is the same regardless of which alloy is used in above proportions. By the above method, no large amount of cold material is added to the iron in the ladle. While the freedom from nuclei may not be quite so complete as when following the first described procedure, it is found there is a greater certainty of the iron being in condition to use.

In discussing the making of high-test iron by the cupola process in the United States of America, it should be remembered that almost all the cupolas are operated without a forehearth. This naturally results in tapping at intervals, between which the iron rises in the cupola to make contact with the coke. The carbon pick-up therefore is much greater, and consequently there is a greater difficulty in obtaining a low-carbon iron in the ladle than if a forehearth were used. To avoid this difficulty there has been an increasing percentage of steel added to the mixture. For this and for other reasons some American foundries are now using a tilting Y-shaped spout in front of the cupola tap hole. This spout makes it possible to run the iron down

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(4A).

either leg or side as desired, and allows the stream of iron to be continuous, for it is not necessary to stop up the cupola. It has been reported by those using this process that mixtures with 25 per cent. steel will result in 0.15 to 0.25 per cent. lower total carbon product than when using the intermittent tapping process.

It is estimated that about 130 American foundries make an intermediate iron from charges containing about 50 to 60 per cent. steel, with a tensile strength of 16.9 to 22.3 tons per sq. in. It is likewise estimated that about 30 foundries use a mixture for high-test iron with over 80 per cent. steel, with test-bars breaking over 22.3 tons per sq. in. This estimate was reported by Mr. F. B. Coyle, of the International Nickel Company.

It might be of interest to outline the details of one example of producing the high-steel charge metal which has been in successful operation for over four years. The cupola is 54 in. internal diameter, carrying six tuyeres assembled as one row. The tuyeres are 19 in. long by 5 in. high, and are equally spaced around the cupola with the lower edge 19 in. above the sand bottom. The by-product coke used contains 8 per cent. ash and 0.7 per cent. sulphur. Two and a-half hundredweights of this coke are used on the bed, most of which is charged on the wood. After burning through, the remainder of the coke is added, and the bed levelled off. In charging, the pig-iron and scrap are put first, the steel is then added and the ferro-silicon thrown on top of the charge. After filling the cupola, it is allowed to stand one hour before the blast is put on.

The metal charges are 1 ton 6 cwts. 3 qrs. in weight, with 3.25 cwts. of coke between charges. The charge consists of from 4 to 5 per cent. of 50 per cent. ferro-silicon, 0.5 per cent. of ferro-manganese, 6 to 10 per cent. return high-test iron scrap, 5 per cent. pig-iron, with the remainder steel. The steel is two-thirds railway wagon springs and one-third steel rails cut to 2-ft. lengths. A blast of 3,600 to 3,800 cub. ft. of air per min. is used, with a pressure of from 4 to 5 ozs. As a low carbon is desired, short taps are made, and the cupola is kept fairly free from melted iron. It would be possible to reduce the total carbon in the iron by using less coke, but in view of the importance of having hot iron, it is preferred to use the coke specified. To each 1,000 lbs. of metal going through the spout, there is added 3 lbs. of powdered ferro-manganese silicon (silicon 50 per cent., manganese 25 per cent.). When large castings are to be made with little machine work, no alloys are added. When small castings are to be made with much machine work, either 1 per cent. nickel or 0.35 per cent. molybdenum are added. Castings made from this iron include frames, tie pieces, hydraulic casings, gears, drums, dies, etc.

The iron so made has a short freezing range, and must be handled quickly. In practice it does not show a high internal shrinkage or porosity. It must be poured hot and fast and sand may burn on to the casting to some extent unless the sand is of a good quality. Dry-sand moulds are to be preferred and large risers should be used

Unetched, × 100.

(4B).

FIGS. 4A AND 4B.—CUPOLA IRON AS CAST. TENSILE STRENGTH 32.9 TONS. BRINELL NO.: 285. COMPOSITION: T.C., 2.64; SI, 2.14; MN, 0.69; S, 0.08; P, 0.08; NI, 1.12; CR, 0.08 PER CENT., AND MO, NONE.

where possible. This iron is considerably harder than the average cast iron and, in fact, machines in a similar manner to a steel casting. The structure is pearlitic, with small graphite flakes.

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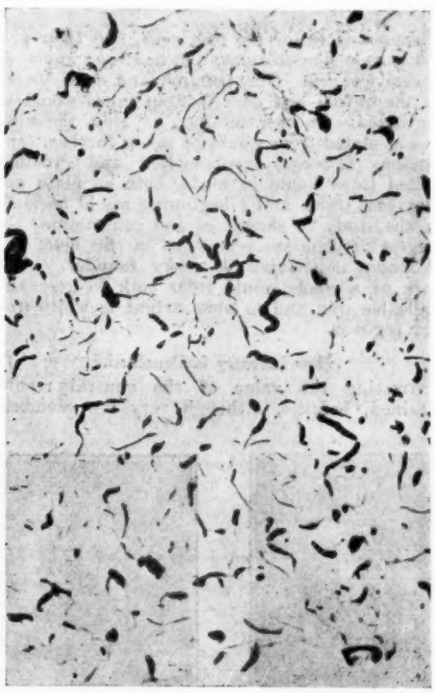
(5A).

Unetched, × 100.



(5B).

FIGS. 5A AND 5B.—CUPOLA IRON AS CAST.—TENSILE STRENGTH, 31.3 TONS. BRINELL NO.: 277. COMPOSITION: T.C., 2.64; Si, 2.16; Mn, 0.73; S, 0.084; P, 0.08; Ni, NONE; Cr, 0.08, AND Mo, 0.34 PER CENT.

TABLE I.—*Physical Tests from Arbitration Test-Bars detailed in Fig. 6.*

(*Iron melted in a 54-in. Cupola.*)

Date cast.	Size ladle, lbs.	Trans. load in lbs.	Def. in.	M.S. tons per sq. in.	Brinell hardness.	T.C.	Si.	Mn.	S.	Ni.	Cr.	Mo.
12/5/31 ..	7,000	5,780	0.16	26.2 25.8*	285	2.73	1.88	0.63	0.079	1.12	Tr.	None.
12/5/31 ..	2,000	5,730	0.14	32.9	285	2.64	2.14	0.69	0.080	1.12	,,	,,
12/5/31 ..	7,000	5,560	0.14	29.7	297	2.50	2.16	0.74	0.078	1.00	,,	,,
11/25/31 ..	7,000	5,600	0.15	26.3	277	2.97	1.88	0.62	0.087	1.37	,,	,,
11/25/31 ..	7,000	5,800	0.16	28.1 28.9*	285	2.87	2.05	0.64	0.091	1.20	,,	,,
11/25/31 ..	2,000	6,270	0.17	29.0	293	2.50	2.66	0.72	0.103	1.29	,,	,,
11/13/31 ..	7,000	5,850	0.17	26.8 26.9*	285	2.79	2.00	0.61	0.088	0.88	,,	,,
11/13/31 ..	7,000	5,630	0.15	24.5 24.5*	293	2.61	2.25	0.68	0.081	1.29	,,	,,
11/4/31 ..	9,000	5,740	0.15	24.5	277	2.81	2.07	0.67	0.093	1.15	,,	,,
11/4/31 ..	2,000	6,020	0.19	29.2	285	2.91	1.97	0.71	0.087	0.97	,,	,,
11/4/31 ..	9,000	5,810	0.16	27.9 27.8*	277	2.82	2.16	0.68	0.080	1.20	,,	,,
10/30/31 ..	9,000	5,390	0.18	24.3	262	3.05	2.37	0.70	0.096	1.01	,,	,,
10/30/31 ..	6,500	5,960	0.19	27.3	262	2.79	2.34	0.75	0.087	0.98	,,	,,
10/30/31 ..	25,000	5,220	0.16	23.1 23.5*	262	2.73	1.93	0.62	0.091	1.03	,,	,,
10/28/31 ..	5,000	5,330	0.15	26.5	252	3.11	1.81	0.67	0.090	0.88	,,	,,
12/11/30 ..	2,000	5,480	0.18	31.3	277	2.64	2.16	0.73	0.084	None	,,	0.34
2/17/30 ..	2,000	6,240	0.18	29.9	277	2.51	2.82	0.74	0.089	,,	,,	0.28
12/22/31 ..	2,000	6,470	0.19	27.8	262	2.74	2.41	0.74	0.072	,,	,,	0.29
(*Iron melted in a 72-in Cupola.*)												
9/9/31 ..	20,000	4,960	0.15	24.8	265	2.59	1.88	0.80	0.089	Tr.	Tr.	None.
7/22/31 ..	44,000	5,160	0.14	22.9	255	2.94	2.65	0.77	0.100	,,	,,	,,
2/27/30 ..	20,000	5,170	0.16	27.6	285	2.60	2.07	0.70	0.100	0.19	,,	,,
11/7/30 ..	40,000	4,850	0.15	25.5	262	2.49	2.07	0.68	0.081	0.18	,,	,,
10/2/30 ..	30,000	5,150	0.14	26.8	269	2.69	2.45	0.83	0.086	Tr.	,,	,,

* These tests were taken from bars of 0.750 in. dia. and 2 ins. between fillets.

There are, of course, possible foundry troubles when using this iron, but none that cannot be overcome.

Table I details results covering a month's run, and includes 15 consecutive routine tests, all with nickel additions being reported. In this table are listed representative tests of several ladles using molybdenum and also of several heats using no alloys. These results are not in any way research or experimental, but were all made on ladles of iron used to produce commercial castings. On 200 consecutive routine tests made in 1929-30 the average tensile strength was 24.9 tons per sq. in. All bars used were standard arbitration bars, 1¼ in. in diameter and broken transversely between 12-in. supports. The tensile test-pieces (Fig. 6) were cut from the broken halves of these bars.

In order to compare these tensile bars with one more nearly like the British standard bar, the following tests were made. Six arbitration bars were taken at random and broken transversely as usual. From the broken ends of each bar two tensile specimens were machined, one into the standard American tensile bar and the other into a tensile bar 0.750 in. in diameter for a clear space of 2 in. between the bottoms of fillets. The results from the latter type bar are those marked with an asterisk in Table I. The results from the American bar are those given in the upper half of the same bracket. As the agreement between the two types of test-bars was good, the remainder of the tests were made on the former type of bar.

A variation in silicon of from 2.0 to 2.75 per cent. does not materially affect the strength. A high silicon, however, does tend slightly to soften the casting. If additional hardness or resistance to wear is desired, powdered ferro-

(*Concluded on page 25.*)

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British Cast Iron Research Association.

OPENING OF LABORATORY EXTENSIONS AT BIRMINGHAM, BY LORD RUTHERFORD OF NELSON, JULY 6, 1932.

The newly-extended laboratories of the British Cast Iron Research Association at 21, St. Paul's Square, Birmingham, were opened on Wednesday, July 6, 1932, by Lord Rutherford of Nelson, Director of the Cavendish Laboratory, Cambridge.

Preceding the opening, there was a luncheon at the Queen's Hotel, Birmingham, at which Sir Harold Hartley, F.R.S. (President of the British Cast Iron Research Association), took the chair.

SIR HAROLD HARTLEY said that the main research work of the Association was directed towards solving the many problems which cast iron presents, and this had made notable progress. About five years ago it was found that various desirable investigations were hampered because insufficient knowledge was available about the combined effects of the numerous elements that may be present in cast iron. The sub-committees for the past year, and their proposals were now complete and had been approved by the Council. The research and development on the cupola and on moulding sands would be continued. On the metallurgical side, the work on inoculated irons would be taken further, comparisons between cupola-melted and crucible-melted irons would be made, both on plain and alloy cast irons, and a beginning would be made on the study of shrinkage and contraction, the biggest problem yet remaining in this field, and of major importance to every founder. The work as a whole would refer both to grey and malleable iron and to some extent to white iron and pig-iron.

How Industry is Benefited.

Stressing the value of the general results obtained, because, although very few members graphitised inside. The Silal link was covered with an almost imperceptible layer of firmly adhering scale, and showed no change in structure. The member adds that they subsequently received a variety of orders for Silal. An influential corporation in this country recently reported that Silal rings in a cement kiln maintained at 900 deg. C. for six months showed a certain amount of growth and very little scaling, and after examination were considered fit to go back into service. The ordinary life of a normal cast-iron ring was three weeks.

Sometimes it was asked whether Silal is tested against the best alternatives available. So far as comparisons reported by the Association were concerned, the answer was in the affirmative, although he wished to make it clear that the Association did not desire to urge members to use this material in preference to other more suitable alternatives. In this respect there was no desire to favour Silal. The Association was prepared quite impartially to recommend the best material for a given case regardless of whether it was Silal or not. Secondly, Silal undoubtedly did require more care and skill in founding than ordinary cast iron, and was really

FIG. 1.—THE LIBRARY AND INFORMATION BUREAU.

FIG. 2.—THE CHEMICAL LABORATORY.

influence of each normal element acting alone was fairly well understood, but of their conjoint influence much less was known. The phrase "normal element" is used because in the ordinary way silicon, manganese, sulphur, phosphorus and, of course, carbon, are present more or less in all cast irons. In modern irons, however, nickel, chromium, vanadium, titanium, molybdenum, copper, and aluminium may also be present, by accident or design. The combined influence of two or more of these constituents had also had to be considered. These additions had enormously increased the complexity of the constituents present and given rise to difficult problems in analysis and microstructure. The Research Committee decided that it was essential first of all to obtain a working knowledge of their effect on the properties of the metal before going further. To do this work with metallurgical completeness would occupy many years of the time of an army of metallurgists provided with much greater facilities than are available to the Association. For the immediate practical purposes of the industry, however, this work has now virtually been completed. In other words, the staff is in a position to predict with reasonable certainty what would be the structure and what were likely to be the properties of any cast-iron alloy containing these elements and capable of being cast in a foundry. The next section to be dealt with has had the very serious consideration of the Research Committee and the various may read in detail the highly technical reports in which the results were embodied, Sir Harold said they were constantly being used by the staff in dealing with queries and difficulties raised by members. He emphasised this point because there was a danger that the attention of members may be more easily directed to one or two discoveries of a more spectacular kind which had emerged in consequence of the work. For instance, several new irons of an interesting and commercially valuable kind have been found. Two of these, Silal and Nicrosilal heat-resisting irons, had made a marked advance in commercial application during the year. The Association now, in fact, had half-a-dozen members formally licensed to produce these alloys and a number of other members had tried them. Of their value there was not the slightest doubt. Thus an Australian member tested three types of stoker links, one made of Silal to the Association's specification, a standard cast-iron link and a white-iron link containing 1.5 per cent. chromium, a common composition for a heat-resisting iron. The links were heated together in a steel annealing furnace for seven 3-hr. periods, to 900 deg. C. The plain link showed a growth of 6½ per cent., the chromium-iron link an increase of 3½ per cent., and the Silal link an increase of 1½ per cent. The first-mentioned was covered with a thick layer of oxide, and had, in fact, oxidised considerably right through. The chromium-iron link had scaled badly and best undertaken when metallurgical control, either immediate or remote, was available. Some applications of it have not given satisfactory results, but in all cases of this kind of which the Association had knowledge, the material turned out to be not of the structure or composition characteristic of a true Silal iron. In some exceptional cases, of course, special conditions come in. Thus, an apparently heat-resisting application might turn out to make quite other demands on the material which make the heat-resisting requirements a comparatively minor consideration. The properties of Nicrosilal were remarkable and justified its description as the best heat-resisting cast iron yet produced. It was ductile in the cold and maintained an extraordinary degree of strength at red heat. It was, of course, more expensive than Silal, and this confines its use to special applications. Specimens case-hardened recently for 40 hours at a temperature of 1,000 deg. C. showed no change in the structure, no carbon having been taken up.

Day-to-Day Problems.

Aid to members in their every-day difficulties and problems and in the industrial development of discoveries had always been one of the primary functions of the Association. This, however, quite definitely slowed up the research programme, since it reduced the staff-time available for investigations and was apt to cause discon-

tinuity. Thus, the time of the Superintendent of the Scottish laboratory was now practically wholly occupied in this way. The work on moulding sands also illustrated this point. It was carried out over the period 1926-30. Its publication to members had been followed by such a demand for the services of the investigator to apply the results, that the continuation of the work on core sands and refractories was hampered. The work of application was a natural and desirable consequence of investigation, but the slowing up of the other work was unfortunate, for it was likely to be just as useful to the industry as the original work. Hence the desirability of that measure of increased support which would enable the Association to maintain staffs both for research and for development, so that both may progress together. A proper balance between the two must be maintained, since founders could only apply the results of research, and if the research ceases, sooner or later there was nothing to apply. There was every reason to believe that as yet only the fringe of the possibilities offered by the materials investigated has been touched.

Balanced Blast Cupola.

Another development which has given great satisfaction is the progress of the balanced-blast cupola. Since the original design no less than 22 cupolas had been installed or are under construction, having a total capacity of 120 tons per hr. The number installed and operating is 15, yielding 85 tons per hour. The number actually put into service during the year was double that installed during the previous year. The first application has been made to the melting of malleable cast iron with great success and its application to steel melting and pig-iron melting will doubtless follow. With three exceptions, where special superheated metal is desired and coke economy is not a major consideration, all these cupolas are working at a fuel ratio of 14 to 15:1, irrespective of size. The sizes range from 21 in. with an output of 1.5 tons per hour, to 54 in. with an output of 12 tons per hour. The Council is thoroughly convinced from the evidence before it that this is the cupola-melting unit of the future and the experience of a member who recently installed a 27-in. bore cupola melting 3 tons per hour is characteristic. The cupola melts 10 or 11 hours per day, the charge carrying about 30 per cent. steel. The coke charge has been reduced over one-third, and cheaper coke of higher sulphur content is being used without increasing the sulphur in the castings. The percentage of foundry defectives has also been very materially reduced. Another member who maintains careful records states that while for a period of ten years his foundry defective castings were 4.4 per cent., since installing the balanced-blast cupola, for a period of a year they have totalled 0.7 per cent. The improvement may be attributed to hotter and cleaner metal free from excessive oxidation. Various improvements have naturally been made in the design by Mr. Fletcher, but the basic principle remains and its soundness has been vindicated for a range of sizes and outputs and a variety of types of casting. The Association has six cupola manufacturers licensed to manufacture this cupola, or to convert existing furnaces.

The general research work carried on had demonstrated the influence of cupola melting on the properties of the casting and these furnished a major reason for the development of this cupola. It had also facilitated the development of what the Association called the "inoculation process," because of the high-metal temperatures obtained, and the Association was now in a position to try this process on an industrial scale. This was a logical development of the germ theory and by its means graphite-free charges melted in the cupola are graphitised in the ladle under such conditions as to give a fully-pearlitic iron with a fine graphite distribution.

Pig-Iron Compositional Tolerances.

Some time ago the Association issued to members recommended methods for the analysis of foundry materials and also for the testing of moulding sands. The Council, in the interests of the industry as a whole, placed these on sale and both editions went out of print. In preparing the re-issues a good deal of experimental work had been necessary in order to settle certain points connected with the new matter which it was proposed to include, and consequently the publication has been held up. They will, however, be issued during the current year. Another important step was taken by the Pig-iron Sub-Committee, in issuing recommended tolerances as regards composition when pig-iron was brought to analysis. This work produced the unusual situation of pig-iron users doubting whether the pig-iron makers could in practice meet the tolerance they themselves proposed, which augurs more favourable relations between these groups than has sometimes existed in the past.

During the year certain problems had been raised in rather an acute form and which were found to affect more or less all the makers concerned. Cupola-melted malleable iron and vitreous-enamelled cast irons were illustrations. In both these directions the interests concerned might with advantage consider whether the Association should be enabled to undertake special experimental work.

The New Laboratories.

The work at headquarters was interrupted for a period during the year on account of the damage by fire to two of the laboratories. The necessity for replacing supplies of gas, water, light and power, which were the main difficulties to be faced in removing a laboratory, caused the Council to consider the possibility of replacing them with more suitable and convenient premises adjacent to those originally occupied. The complete removal had recently been accomplished and it was to mark this change that Lord Rutherford had honoured them with his presence. The new accommodation offered 60 per cent. more space than was previously available, and was much more convenient and compact. An even larger proportion of the area than previously was devoted to research and development. In the arrangement of the necessary lay-out the Association was greatly indebted to Mr. F. J. Cook, M.I.Mech.E.

Efficiency and Tariffs.

The period of industrial uncertainty which has made the progress of the Association such uphill work was showing signs of improvement. The home market for castings should be now assured to the home manufacturer and the industry should share very materially in the improved prospects of the other industries to whose plant and equipment it was such an essential contributor. These conditions should materially strengthen the trade associations in the industry and there were signs that these bodies were prepared to offer some support to the Association as groups. This was important, because in the Association the industry had a unique instrument for representing them on purely technical matters, in dealing with national standards and specifications, users' demands, and so on, and was a means ready to hand whereby they might convince the Import Duties Advisory Committee that they were striving to reach that degree of industrial efficiency which would justify both to Parliament and to public opinion the continuation of protection. Furthermore, the increased trade activity should aid the industry to make provision, through the Association, for those studies which will enable us to keep abreast of foreign developments.

Financing Research.

When the financial year opened, the Association was under contract with the Department of Scientific and Industrial Research, whose secretary, Sir Frank Smith, had been so active on their behalf, to increase the support from the industry. In the previous year the subscriptions from the industry had totalled about £5,000, and the grant was a similar amount on the £1-for-£1 basis. The Department, two years ago, in anticipation of the end of our first ten-year period in June, 1931, offered to continue this grant if industrial subscriptions could be raised to £10,000 or, alternatively, offered a grant of £2,500 if the industrial subscriptions could be raised to £7,500, this latter figure maintaining the same total income, although the Association could, with profit to the industry, expend the larger sum of £15,000 per annum.

The depression prevented the realisation of even the lesser of these schemes, and the only alternative to a very serious curtailment of the work of the Association was to ask the Department to reconsider the grant basis. In addition to difficulties within the industry, the situation was complicated by the extreme strain on the national finances, which compelled economy in every quarter. However, the difficulties were ultimately overcome, and the Department finally agreed to furnish a maximum grant of £3,000, provided the industry during the year raised the sum of £6,250, making a total of £9,250. For the year now beginning the grant of £3,000 will be paid only if industrial subscriptions of £6,500 are received. A total income of £9,250 for the year just closed naturally meant a reduction from the five-figure income reached the previous year, which has been met in various ways, mainly by the reduction of staff salaries. The required sum of £6,250 has been obtained, and consequently the maximum grant of £3,000 has been earned. While this falls materially short of anticipations and desires, it is perhaps, under the conditions prevailing at the present time, not unsatisfactory.

Equipment.

The Association still needed apparatus and equipment vital to its work and which it was at present unable to acquire. Several advantageous offers have been made to the Association by manufacturers to supply apparatus and equipment at cost price or less, but it was unable to take advantage of them owing to lack of funds. Among the more important needs are an electrical induction furnace, a cupola melting furnace, a rotary pulverised-fuel furnace, a malleable annealing furnace, apparatus for dilatometry, for electrical and magnetic testing, extensometers, apparatus for testing fatigue and wear, improved apparatus for chemical analysis and photomicrographic work and for pyrometry.

Sir Harold Hartley concluded by proposing the health of Lord Rutherford, which was honoured with great enthusiasm.

LORD RUTHERFORD, who was very warmly received on rising to respond, said he had tried in his official capacity to visit some of the research associations in charge of the Department of Scientific and Industrial Research when he could, and it was a very great pleasure to visit Birmingham again and to meet the members of this Association to-day. The Director, Mr. Pearce, had provided him with a large amount of literature dealing with its activities since the inception of the Association, and with the reports and publications that had been made, but he confessed that he had not read with scientific care the mass of literature, but he had read sufficient to recognise what valuable work had been done by the Association, and the research staff, for the industry. When one considered the exiguous finances of the Association and often the difficult conditions under which the work had been done, the output of solid and valuable work was very impressive. He quite appreciated what a formidable problem it must have appeared to achieve practical results within such a limited period. After all, this industry was a very old-established one, and like most old

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things, was somewhat conservative in temperament. The present technical position of the industry had arisen largely as a result of the empirical trials and observations of generations of practical men, and at first sight it would appear impossible for anything in a marked way to be done to improve the industry. But closer examination showed that there was really extraordinary little understanding or knowledge of the fundamental processes underlying this great industry. Cast iron was a very complicated material, and it depended on a multitude of conditions of which little was known and in a way difficult, also, to disentangle from one another, and it was thus clear that if any definite progress was to be made within a reasonable time it was necessary to get a much clearer knowledge of the underlying processes that take place between the furnace and the finished product.

The research staff had tackled this formidable problem with great courage, and we may claim today that the industry was much indebted to them for the fine work that they have done. Reference has already been made to several important directions of the work. There is first side and trying to understand the processes that occur from the furnace to the finished product. That was a point of very great interest, and it should be of very great interest to the Association, because it indicated the great possibilities that may accrue to the industry by encouraging the Association. For example, it was one thing for every foundryman to be producing the same type of casting in the way their grandfathers did, and with cut-throat and unrestricted competition between them. It was another thing if it was possible to produce grades of castings that were specially useful for a specific purpose, and the interest of those who develop these new methods in making such new types of iron in which there would be not only scientific interest, but which would also be economically more valuable. There were to-day, and there would be in the immediate future, probably many developments of that kind even in what appeared to be the relatively limited field of the foundry industry. He heard only last night of some very interesting developments that were in progress in Germany at the moment of which no doubt more would be heard in due course. When we consider the importance of time carry on systematic researches that would be of ultimate value to the industry. No one could overestimate the value of such a vigorous Research Association to the industry, and such an Association must develop in that way if Britain was to hold its own in the intense international competition which was such a marked feature of the modern world.

From the political, financial and economic changes that have occurred in the past year, it was clear that those changes must profoundly modify the outlook of national industries. Industries which were before exposed to the blast of unrestricted competition now enjoy the comparative shelter of a protective tariff. It was earnestly to be hoped that advantage would be taken of this opportunity for the reorganisation of industry, the modernisation of its apparatus and last, but not least, the development of research work which experience had shown was essential if industry was to compete on equal terms in the world of to-day. An inquiry was now on foot into the conditions of the iron and steel industry, with a view to putting forward proposals to increase the efficiency of production. He was unaware, as a layman, how far the

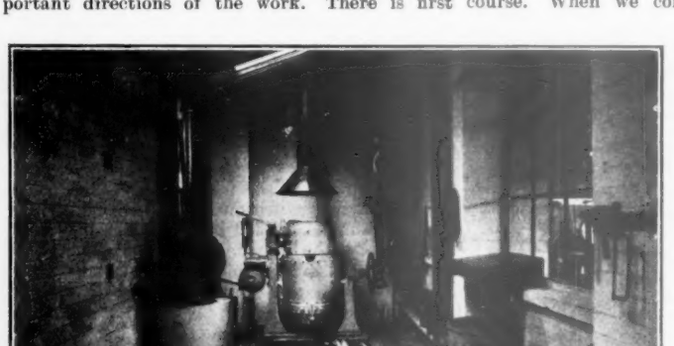

FIG. 3.—THE MELTING SHOP.

FIG. 4.—THE PHYSICAL METALLURGY LABORATORY.

of all the design of a new type of cupola, and it is clear that not only were these new cupolas more economical in the use of coke, but that they also produced a better type of iron, and at a conservative estimate it was calculated that if this type of melting unit was utilised throughout the whole industry that should be covered by this Association, there would be an annual saving of £100,000 a year. Then there have been extensive investigations into the properties of moulding sands and the design of simple and inexpensive apparatus for determining the effectiveness of sand under working conditions, and in that case it was claimed that a saving of almost the same order of magnitude would result if these new suggestions were utilised by the industry. But he had been particularly attracted to the experiments that have been made and which are specially associated with the names of Dr. Norbury and Mr. Morgan on the production of new types of iron with a high content of silicon—Silal and Nicrosilal. These results were quite new to science and new to industry. It had been found that these new types of iron were specially resistant to heat and would be of special service in certain directions in industry. It was of interest to know that these investigations, and also others, have not resulted from a direct empirical attack on some, what we may call, *ad hoc* problem or difficulty in the industry. They have largely followed from approaching the industry from the fundamental the foundry industry to the State and the high monetary value of the products of the industry, the financial support of this Research Association was by no means commensurate with the needs. At the moment only a fraction of those whom the Association would naturally help were paying members, and he hoped that it would be possible in the near future to increase rapidly that *clientèle* and the funds of the Association.

What should be the possible scale of such a Research Association? He believed that the value of the products of this industry were of the order of £40,000,000 a year, no doubt scattered in small units throughout the whole country. If one supposed that one-tenth of 1 per cent. were available for research it would bring in an income of £40,000 a year, and it seemed to him that that is the order of magnitude which should be arrived at in fixing the ultimate scale of this Association. One might say quite properly that £40,000 seems very large in these depressed times, and reference had already been made to the great difficulty of collecting even a small fraction of that amount. He felt in some respects that the original idea of the Association was pitched in a somewhat low-financial scale, and he hoped that that would be remedied in the future. He visualised a research staff that would advise its members on their technical difficulties whilst keeping them closely in touch with the work in their subject that was going on in all parts of the world and at the same foundry industry itself came under that category; but there was one point on which he was quite clear, namely, that the public would expect any industry that was protected by a tariff should be thoroughly aware of the need of organisation and also the need of scientific research. The most obvious and valuable sign that an industry was alive to its duties was in financing a research association to improve its products. He was hopeful that this change in affairs will lead in the near future to a rapid extension of this idea of each industry having by its side and under its control a vigorous research association, and with funds commensurate with the scale of the industry concerned.

In conclusion, he wished the laboratory every success in the future. It was a great pleasure for him to be there and he especially thanked the Chairman for the very kind welcome that he had accorded him.

MR. H. B. WEEKS, Chairman of the Council, in proposing the toast of the guests, said:—"I have a very important, but exceedingly pleasant duty to perform. It is that of proposing the health of our guests, and to thank them for the sympathy and support they have shown in the work of the Association by their presence here to-day. I am but voicing the wishes of the whole of our members when I ask our guests to accept this expression as being something more than a mere matter of form, but an expres-

(*Concluded on page* 26.)

Institute of British Foundrymen.

MEETING COMPETITION BY NEW DEVELOPMENTS.

MR. V. C. FAULKNER (Past-President), who opened the discussion, said it was his experience, and he asked for Dr. Rosenhain's confirmation of it, that if one cast a metal too hot—from the foundryman's point of view—no matter what the metal might be, one would find cutaneous blowholes or pinholes in the casting, varying, naturally, with the size of the casting. If one cast either type-metal or a nickel-chrome steel ingot at too high a temperature, one would generally find these surface blowholes.

With regard to malleable, it was a fact that in the south of England it had been made during the last five or six years quite regularly, the residual heat from the electric furnace, after it had melted steel, being used as an economic means of melting the malleable.

A practice which might be extended with advantage was the use of bottom-pouring ladles. It was exceedingly common practice to use such ladles for steel casting; they were used to a very much less extent in the non-ferrous industry —perhaps in only two non-ferrous foundries in Great Britain; but he had never heard of a bottom-pouring ladle being used for making iron castings. He submitted, however, that for certain types of castings the foundryman would have better control of pouring conditions, so far as time and quantity were concerned, if he used bottom-pouring ladles.

Mr. Faulkner then went on to refer to the phenomenon of pre-solidification of metal, the discovery of which was usually credited to Dr. Rosenhain's very erudite assistant, Mr. S. L. Archbutt. Very low-carbon steel, which was probably the most difficult metal to cast soundly —at any rate, within the whole field of his own experience—could be cast very well provided one allowed it to reach almost to a pasty stage and then remelted it. There was no need to allow it to get completely cold—that would be far too expensive—but by just altering the equilibrium the metal gave up its gas and one could cast it quite successfully even by what was known as the "hen and chickens" method. He had seen this done at Gerlafingen, in Switzerland, and the experience there had checked up with the experience he had had when working with Mr. Stobie.

Competition from Resin Products.

Another direction in which he asked Dr. Rosenhain for assistance was that of meeting the tremendous competition which the foundry industry was facing from plastics. One heard of the whole of the bathroom fittings and door furniture of transatlantic liners being made of resinous products, whereas in the past fittings of that type for a liner had meant orders to the value of several thousands of pounds to the brass-founding industry of Birmingham. In order to compete with such products, the foundry industry would like to vitreous-enamel aluminium-alloy castings. That involved a temperature of 850 or 900 deg. C., however, which was too near the melting point of the majority of light alloys. One potential solution of the difficulty was the use of beryllium. He believed that this metal was lighter than aluminium, and melted at 1,200 deg. C., which would give the necessary margin of temperature for vitreous enamelling. He believed the price of beryllium at the moment was about £17 per lb., but there was some hope in regard to price, because only five or six years ago it was something like £3,000 per lb.

In this connection also he mentioned the dyeing of aluminium castings, and said that if they could be produced in beautiful colours this practice seemed to offer to the foundryman an opportunity to compete with plastics.

Finally, discussing the competition of welding, he said that some little time ago people had started to manufacture road rollers from weldings, but he had heard that the weldings were being returned to the shops and were to be replaced by the more rigid form of fabricated material—cast iron.

Darlington Bottom-Pouring Cast Iron.

MR. J. H. COOPER, commenting on Mr. Faulkner's statement that he knew of no iron foundry in this country in which bottom pouring was being used, said that bottom-pouring ladles were being used very successfully in one of the largest iron foundries in the country. There was a tremendous difference between the bottom pouring of iron and steel. Iron needed to be poured as quickly as possible, but steel had to be poured at reasonable speeds. In some large steel castings made at Darlington the pouring had occupied from 7½ to 8 minutes; but in the case of some large iron castings, where it was necessary to fill the moulds in the shortest time possible, the pouring had occupied only 50 or 60 seconds. The chief difficulty was the lifting of the stopper. One had to use a plumbago stopper in a clay pot; if one used a clay pot and a clay stopper, they would very often stick together and could not be opened. The difference of time occupied in the filling of a steel mould as compared with iron was for the purpose of enabling the founder to overcome in some measure the liquid contraction which occurred. He believed that bottom pouring of iron would be successful in small work if one could prevent the slag, which in some cases was very fluid, working down to the bottom of the stoppers. Whereas in steel casting one had only to use the ladle once and had not any more steel ready for a few hours, except in convertor practice, where metal was being tapped continually, there was sometimes very great difficulty in preparing ladles in the time available.

Copper in Cast Iron.

MR. B. HIRD said that in many foundries the old foundryman had dealt with any metals that came his way, and had had a good rule-of-thumb knowledge of both ferrous and non-ferrous. Now, recent development seemed to be linking the non-ferrous and the ferrous industries. In this connection, he instanced the addition of copper to steel in an attempt to reduce corrosion, and he asked Dr. Rosenhain if there were any possibility of adding copper to cast iron in order to secure the same advantages as when it was added to steel. He also asked what amount of copper would be present in a 0.2 per cent. carbon copper-bearing steel.

Factors in Non-Ferrous Melting.

MR. F. W. ROWE, as one belonging to an organisation which operated large steel, iron and bronze foundries, suggested that Dr. Rosenhain, in his enthusiasm, had perhaps somewhat overemphasised the differences between steel, iron and bronze foundry practice. Such conditions as he had outlined in his Paper probably did obtain 10 or 15 years ago, but in some phases of foundry practice these differences had become less wide and anomalous. For example, in regard to sands for moulds and cores, it was quite common practice to use silica sands with a binder, commonly known as oil sands, in steel, iron and bronze founding. Steel castings were being made in moulds with what might be called oil-sand cores, and he believed that a very large part of the engineering bronze castings were made with oil-sand cores and not baked loam.

Discussing the electric melting of bronze and cast iron, he questioned Dr. Rosenhain's statement that the Ajax-Wyatt type of induction furnace had swept the stage. At the most, up to 18 months ago 80 per cent. of the engineering bronze castings in the United States, to his knowledge, were melted in the Detroit rocking-arc type of furnace.

DR. ROSENHAIN: I was referring to brass.

MR. ROWE said he appreciated that the use of the Ajax-Wyatt type of furnace was extending in the foundry industry, but until recently the Detroit rocking-arc furnace was the one largely used in the founding industry in the United States. The fact that the use of that type of furnace had not extended to this country was not due to apathy or conservatism on the part of our bronze founders. The most serious difficulty in the extension of its use in this country was the fact that it was a single-phase furnace, and there were very few power-supply authorities who would allow a foundry to impose such a large out-of-balance load as a reasonable-size rocking-arc furnace would entail. Also, in that respect he was not entirely sure that the Americans, in their enthusiasm for electrical heating and melting, had adopted the most economical means of melting non-ferrous metals for the foundry industry. The question had been investigated seriously by many responsible people in this country, and he believed that in the increased popularity of the forced-draft reverberatory furnace we had made a distinct step forward in advance of the United States. That type of furnace, particularly for the commonly-used gun-metals and bronzes of low zinc-content, gave extremely satisfactory results from all points of view, and there was no doubt that the use of that type of furnace had been extended successfully in this country to a much greater extent than in the States.

Possibly he had misunderstood Dr. Rosenhain's reference to the cupola as not being an efficient melting unit, but his own opinion was that the persistence of the use of the cupola as a melting unit for cast iron was due to its undoubtedly very high thermal efficiency. The thermal efficiency of the cupola under good conditions was between 40 and 45 per cent., and there were very few other melting units, apart from electric furnaces, in which anything like that efficiency was attained. The efficiency of the ordinary pit-fire or bronze or brass melting furnace, or the induced-draft crucible brass or bronze melting furnace, was between 4 and 6 per cent., and the efficiency of even the forced-draft reverberatory furnace, either coke-fired or oil-fired, was not above 15 or 20 per cent.

Mr. Rowe quibbled with Dr. Rosenhain's insistence that the term "die casting" should be applied only to die castings made under pressure. After all, the literal interpretation of the word made no reference to whether or not pressure was used. He suggested that the adjective "pressure" should be added to indicate exactly what was meant. He considered that he was justified in applying the term "die casting" to anything which was cast in a die whether pressure was used or not.

Finally, he expressed gratitude to Dr. Rosenhain for his Paper on a subject which was very well worthy of very close consideration, and he hoped the Paper would stimulate the founders to give due attention to the application of particular phases of one section of the industry to the other.

"Flaming" Dressings.

MR. COLIN GRESTY, referring to Dr. Rosenhain's remarks on "flaming" mould dressings, said he gathered that that expression covered the use of coal dust in green-sand work, which was universal practice; thousands of tons were used every day. He did not find in the Paper any suggestion as to what should be used in its place. The output of green-sand castings in the making of which flaming dressings were

* Dr. Rosenhain's Paper was used by the visitors to the Newcastle Conference as a means for getting new angles about their own practice.

used was such that their use seemed fully justified, and he believed that in the majority of cases there was no evidence that this was a serious cause of gas-holes. No doubt there were certain cases in which trouble could be caused in this way, but in his view the fact that flaming dressings were used universally rather contradicted Dr. Rosenhain's remarks. He believed also that in using chill moulds for non-ferrous work it was very common practice to oil the moulds before casting. Perhaps that was not so universal as he believed it to be, but certainly he had seen it done and he presumed that the object was largely to allow the casting to strip well, due to the cushioning action of the gas produced from the oil.

Dr. Rosenhain's reference to the small differences in the temperatures to which sand was exposed in different classes of foundry work was not in line with most people's experience.

Dr. Rosenhain said that he was referring in that case to cast iron and bronze and did not include steel.

Mr. Gresty indicated that he had misunderstood the reference.

AUTHOR'S REPLY.

Oil Dressings.

Dr. Rosenhain replied to the discussion. After expressing his thanks for the reception accorded his Paper, he said the points that had been raised provided proof that there were a great many questions upon which those who had gained experience in different fields differed quite appreciable. For example, Mr. Faulkner had mentioned the casting of metal at too high a temperature. No doubt that always did cause trouble of one kind or another, but by no means always was that trouble in the nature of subcutaneous blow-holes. This latter was mixed up with the question of mould dressing. When referring to flaming dressings, he had had in mind the oil dressings on metal moulds rather than the coal dust in the green-sand moulds. In a sand mould, where there was any amount of porosity and plenty of opportunity for the gases evolved by the burning of the oil to escape, the chances of producing gas-holes in the castings were very much less than in a permanent mould. He quite agreed that at the present time, in this country at all events, the use of oily dressings in moulds was still very widespread. He drew attention, however, to recent work, published by the Non-Ferrous Metals Research Association, on the casting of brass ingots for strip making. In that work the very deleterious effect of these oily dressings was shown, and the work had indicated how very much better results were obtained if more suitable means were adopted. The investigators had suggested a flame of oil or gas burning at the top of the mould to protect the metal as it flowed into the mould, and not having any oily material in the mould. The fact that flaming was used universally proved only one thing, that it produced results which were tolerated up to the moment. It did not mean necessarily that it was the right thing to do—although he quite agreed that anyone who wished to appear to be a reformer in an ancient industry must tread warily, because he would very often find that if he disposed of one disadvantage he would run into others which were even more troublesome, and a long and weary road had to be travelled before all of them were overcome. At the same time, it was well worth discussing and recognising the difficulties experienced with the devices now in use. He was not attempting in the Paper to lay down the law, or even his own ideas as to the right practice or even existing practice; all he had tried to do was to call attention to a few outstanding features of practice as he happened to know it here and there over a wide range throughout the world in the different branches of the industry.

The use of the bottom-pouring ladle was a matter for which he had been doing propaganda for some years; it seemed to him to be obviously the right and rational way of casting. The difficulties which arose in certain metals, he believed could be due only to the choice of bad refractories for the particular furnaces. If a clay stopper stuck in the clay lining of a ladle, it was possible to overcome the difficulty by the use of a better clay or of some different material. Plumbago apparently could be used, but he imagined that siliceous material might be quite good. He saw no inherent reason why cast iron, or copper, for that matter, should not be poured from a bottom-pouring ladle, and the speed of pouring could also be adjusted as desired. Although he believed it was the practice to fill some moulds at an appalling pace, the ideal, from the metallurgical point of view, was to fill the mould as slowly as it could be properly filled. If one filled the mould very quickly and tried to overcome contraction in that way, one would do so at the expense of blow-holes produced in the casting. However, that was a very wide subject and he did not think he could go into it further on this occasion.

Pre-solidification.

He was very much interested in Mr. Faulkner's remarks concerning pre-solidification. If the metal did not become particularly solid it was not strictly pre-solidification; it was an approach to it, but not equally efficient. Other methods of removing gases, and which also had been developed partly by Mr. Archbutt, were to blow in neutral gases, and so on, and they were very much more efficient and cheaper; they did not occupy so much time, and did not use so much heat, and he considered them preferable to pre-solidification. He did not think anyone had attempted them in steel, but he believed it would be tried before long.

Dyeing Aluminium-Alloy Castings.

The competition of plastics was being met to some extent by the aluminium industry. The vitreous enamelling of aluminium was not very hopeful because of the low melting temperature of aluminium. The use of beryllium was not practical politics at present; not only was the metal too expensive, but it was a hard and brittle material in any form in which it was produced. It should not be, if it were produced quite pure, but it had not been so produced, and for practical purposes its use as a basis metal was out of the question and was likely to remain so for some years. Its price was falling rapidly; meanwhile the treatment of aluminium castings and pressings by the anodic oxidation process, followed by dyeing, was giving extremely interesting results. Practically any colour could be obtained, and the resulting product was extremely resistant to corrosion. It was being used where vitreous enamels might otherwise have been used. The process was being improved almost day by day and there were a great many aluminium articles which had been treated in that way and which one would never recognise as being aluminium. It was almost a pity that that was so; nevertheless, they had very great advantages and they were substantially non-conducting. One of the claims made for the Bakelite switch was that it was non-conductive, but the anodically-covered aluminium articles were practically as insulating as Bakelite. Anodically-covered wires were being used for winding transformers.

Copper in Cast Iron.

Dr. Rosenhain was unable to answer off-hand the question with regard to the amount of copper used in certain steels, but he believed the amount of copper varied a good deal according to the ideas of the producers of this material. It was possible to put in quite a large amount of copper if one desired to, but usually it was of the order of 0.1 to 0.2 per cent. There was in existence an alloy of cast iron—in the sense that it was made in the cupola—in which Monel metal scrap was mixed with pig and/or scrap, and it was extraordinarily good. It was a remarkably interesting material; it contained a good deal of nickel and copper, but, being made from scrap material, it was not expensive. It machined extraordinarily well and was very resistant to corrosion, and he imagined that it was quite a rival to brass except for its appearance; it had a dark coppery colour.

Relative Furnace Efficiencies.

Commenting upon the remarks of Mr. Rowe, he said it was always interesting to hear other people's views, even if one did not accept them. He was glad to have been told that he had overemphasised the difference between ferrous and non-ferrous practice, for he had been afraid that he would have been told that he had not realised how great the differences were. With regard to the Ajax-Wyatt furnace, he quite agreed that it was used mainly, though by no means exclusively, for brasses, and that the castings made from the brass were not used as castings, but for tubes and other things. Nevertheless, they were the products of the founder's art, whatever use was made of them. The Detroit furnace was used widely in America, and it had always seemed to him to be very remarkable that it should have been so successful. It was, comparatively speaking, a crude appliance, and he was not sure that in the long run we should not be all the better for not having attempted to use it in this country, owing to the conditions of three-phase supply, which were almost universal here. There was no doubt that the electric-supply authorities of this country did stand in the way of electric-furnace application in many cases, because they did not encourage the kind of load which these furnaces would entail. Steel undertakings, of course, were large enough in many cases to have their own power supplies, or at any rate to convert in such a way as not to interfere with the general system. It was true, of course, that to ask to impose a large out-of-balance load on the three-phase system was asking a great deal, but one could hardly be expected to use three furnaces at a time in order to keep the load in balance. He agreed with Mr. Rowe that the reverberatory furnace had made great progress, but he was not at all satisfied that it produced the best-finished article. The metal was exposed to prolonged contact with the furnace atmosphere, and he believed it was being found increasingly that that exposure was highly undesirable—more so in some metals than in others. Consequently, if we could find an efficient melting device in which such exposure was avoided, we should certainly do better. He agreed also with Mr. Rowe's remarks concerning the purely thermal efficiency of the cupola. After all, he supposed the maximum thermal efficiency was obtained in the Bessemer convertor, and if one burned the fuel in contact with the metal, as in the cupola, there was a high thermal efficiency. He had in mind, however, the overall efficiency, including metal losses. Clearly the pit fire was inefficient. But until something better was available it had been the only means by which to preserve the purity of the metal. The high-frequency furnace gave us a better opportunity of doing that. He was by no means an advocate of the pit fire.

Die-Casting.

With regard to the meaning of the expression "die-casting," his quarrel was that the word "die" was misused when applied to an ordinary chill mould. A die was something used for applying pressure, and not merely a mould, and, consequently, he considered that the use of the term "die-casting" for something which was solidified in a metal mould, simply because it was in a metal mould, was a little misleading. At any rate, he considered it unwise, from the trade point of view, to apply to such castings a name which, in the interests of the trade, should be reserved for application to things in the making of which pressure was used. However, it did not very much matter whether we called these things die castings or cabbages so long as we understood what we meant.

(*Continued on page* 25.)

High-Test Cast Iron in the United States of America.

(*Concluded from page* 19.)

chromium may be added in the spout. Higher strength values are obtained by using a higher percentage of alloys. The cost is increased, however, with the higher percentage of alloys and there is a limit beyond which it is not commercially practical to go. The author has not proceeded with the heat-treament of this iron as the size of his firm's castings is such as to make this inadvisable.

Castings have been made which weighed 50 tons in the rough and there is no reason to believe there need be any particular limit in size. Two cupolas 72 in. diameter were used to melt the iron for these castings. Some time ago a 25-ton casting was made and broken up for test purposes. Arbitration test-bars cast from the ladle iron broke at 22.5 tons per sq. in. Tensile bars machined from a rib 2½ in. in thickness broke at 18.7 tons per sq. in. and tensile bars trepanned from centre of a 6-in. section in middle of casting broke at 13.3 tons per sq. in. The grain was fine and close throughout. No shrinkage or spongy spots were found where light and heavy sections came together. The

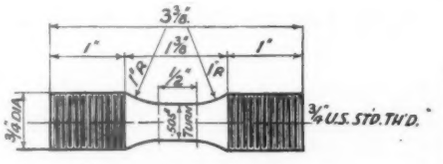

FIG. 6.—TENSILE BAR USED.

analysis of this metal gave:—T.C., 2.73 per cent.; Si, 2.36; Mn, 0.73; S, 0.09; P, 0.08 per cent.; chromium, nickel and molybdenum were not incorporated in the mixture.

Miscellaneous Physical Properties.

Effect of Section.—This higher test iron shows less loss of strength in heavy sections than the other irons lower in tensile strength; also, the structure is more nearly uniform throughout, although the grain becomes somewhat more open as the centre is approached. The hardness of a 4-in. section was practically uniform.[1]

Elongation is low, only 0.5 per cent. being observed in untreated bars.

Fatigue.—A plain high-test cupola iron with a tensile strength of 22.4 tons per sq. in. was tested in fatigue, using the "RR" Moore machine. The endurance limit[2] found was 10.7 tons per sq. in.

Effect of Heat.—An effort was made to determine the effect of a prolonged heating at high temperature.[3] It was hoped that the low carbon and fine grain would maintain its hardness and strength. This did not prove to be so, although the specimen containing chromium was better than the others, the major change taking place in the first 500 hrs. Specimens were held at 593 deg. C. for 8,000 hrs., the test being interrupted at long intervals to determine loss of strength and hardness.

Impact.—This iron shows a much higher impact value than the lower tensile strength irons. There is as yet, however, no standard methods of comparison.[4]

Wear.—There are many references in published literature to increase resistance to wear in using this iron, but the writer has seen no reliable data. This is a subject on which there is a great need of research. In writing the above an effort has been made to eliminate theory as far as possible and to outline only operations in commercial practice.

In conclusion, it is the author's opinion that the development of cast iron is only in its infancy. Heat-treatment and alloys will do as much for cast iron as they have done for cast steel. Grateful acknowledgment is accorded to the following persons and organisations for permission to publish information concerning the material from their respective foundries:—Mr. H. E. Bromer, Standard Racine Foundry Company, Racine, Wis.; Mr. H. B. Swan, Cadillac Motor Car Company, Detroit; Mr. H. S. Austin, Campbell, Wyant & Cannon, Muskegon, Mich.; Mr. D. F. Forbes, Rockford Northwestern Malleable Corporation, Rockford, Ill.; Mr. W. J. MacNeill, Federal Malleable Iron Company, West Allis, Wis.; Mr. Oliver Smalley, Meehanite Corporation, Chattanooga, Tenn.; Mr. J. J. White, Erie Malleable Iron Company, Erie, Pa., and Mr. Wm. Watson, Allis-Chalmers Manufacturing Company, Milwaukee, Wis.

1 R. S. MacPherran, "Effect of Section and Various Compositions on Physical Properties of Cast Iron," Proceedings A.S.T.M. (1929), Part 2, Vol. 29, pp. 76-82.

2 J. B. Kommers, "The Static and Fatigue Properties of Some Cast Irons," Proceedings A.S.T.M. (1928), Part 2, Vol. 28, pp. 174-197.

3 Apparatus described in Paper, "Effect on Cast Iron of Prolonged Heating at 800 deg. to 1100 deg. F.," by R. S. MacPherran and R. Krueger, Transactions A.F.A., Vol. 38 (1930), pp. 826-855.

4 H. Bornstein, "Impact Testing of Cast Iron," Proceedings A.S.T.M., Part 2, Vol. 29 (1929), pp. 109-114.

Training for Business Careers.

The completion of the first teaching year at the Department of Business Administration brings to its close the initial stage of an experiment in training for business management fraught with great potential importance for the future of British industry and trade. Established in 1930 at the London School of Economics through the joint efforts of leading business firms and the School authorities, and financed mainly by business subscribers, the Department of Business Administration provides selected students with full-time training in the broad principles of business administration and, where necessary, gives as well a preliminary training of a general economic character.

In the year just closed twelve students attended the full-time business course, while a further thirteen started the preliminary economic course. Five students were nominated by their firms for full-time study, and a further five were nominated for evening study. Such nominations can only be made by firms subscribing £50 a year or more to the funds of the Department. The remaining students comprised men fresh from the university, a chartered accountant, an ex-army officer of high rank, and several men with business experience and a good general education. One student was a woman.

Since the students on the average were 24 years old, their training will stand them in good stead as in the future they advance to responsible posts. Their employers should benefit similarly. Training is restricted to students possessing high educational qualifications. In the full day-time course the specialised business subjects comprise marketing, production and business finance, and deal with statistics and accounting and the principles of personnel management from the point of view of executive control.

Applications are now being received for admission to the next course which starts in the autumn, and further information, together with application forms, may be obtained from Mr. Jules Menken, the Head of the Department, 11, Clement's Inn Passage, W.C.2.

Increased Use of Nickel.—In the manufacture of nickel steel the amount of nickel used per ton of alloy steel produced in the United States increased about 25 per cent. in 1931 as compared with 1930. Although the amount of nickel cast iron produced in 1931 was less than in 1930, the amount of nickel used in cast iron per ton of iron castings produced increased by about 20 per cent.

Steel Castings Made Without Sand.

In recent years there has been a good deal of gossip as to a novel process which was credited with the elimination of sand in the manufacture of steel castings. The French magazine L'Usine is the first to give any authentic account of this development. Their representative states that the castings are made by the utilisation of the Randupson Process of which the Ugine steelworks possess the sole licence. They have, by the way, granted several sub-licences to other foundries. This process, which is applicable in all foundries utilising the dry-sand process, eliminates the use of boxes, ovens and a portion of the upkeep costs associated with sand, as considerably less raw material is used. The process is stated to bring about extreme regularity of manufacture by transferring all technicalities to the office and the complete elimination of skilled moulders, as any good workman can prepare the moulds. All this, it is claimed, reduces the cost price of the castings.

The process consists of replacing sand by a cement of a special composition, which is adjustable according to the type of metal cast. It carries a very small quantity of water and takes about eight days of air drying for preparation, all stoving being eliminated. The raw materials are brought and stocked in large bins and are passed through mixing and crushing mills with a certain amount of water. The resulting mixture is now ready for the preparation of moulds, utilising patterns as with ordinary sand practice, compressed air-driven hand rammers being used. The moulds are dried on racks and they become hard like cement. At the time of the visit the foundry was engaged upon the casting of stamps in manganese steel for crushers. The moulds are only used once, but the cement is salved, crushed and utilised once more for the preparation of fresh moulds.

Institute of British Foundrymen.

(*Concluded from page* 24.)

Dealing with Mr. Gresty's reference to the temperature of sand, he said he had mentioned specifically the very high temperature to which steel-moulding sands were exposed, and the necessity for the use of very refractory sands there. In another portion of the Paper he had compared brass and bronze castings where the difference of temperature was not very appreciable.

Finally, he emphasised that the object of the Paper was not to raise controversies but to draw attention to some of the influences in adjacent fields of activity to which the foundrymen, in the course of their busy lives, might not have much time to direct their attention.

The PRESIDENT (Mr. Stobie), dealing with the question of thermal efficiencies in furnaces, said that quite frequently he had obtained over 90 per cent. efficiency with high-frequency steel-melting furnaces, calculating on the most reliable specific and latent heats that were available for the materials dealt with.

Semi-direct Production of Nickel Steel from Sudbury Ore.—MESSRS. T. W. HARDY and H. H. BLEAKNEY, in Memorandum No. 54, issued by the Mines Department of Canada, describe a process by which a nickel-iron sponge may be produced from sulphide ores such as occur in the Sudbury district of Ontario. The results of steel-making experiments in which standard steels were made from this sponge are presented, as also the results of mechanical tests on these steels after commercial heat-treatments. The data presented show that steels have been made by this process that compare favourably with steels made by the usual method. While the work does not permit of the formation of a definite conclusion regarding the economics of the process, there are good reasons for believing that it has commercial possibilities, since none of the various steps in the process are difficult and most of them are already in practical operation in other processes.

This Week's News in Brief.

Trade Talk.

THE STAR IRON WORKS, LIMITED, is being wound up voluntarily. The liquidator is Mr. R. G. Howard, 18, Waterloo Street, Oldham.

MESSRS. G. & J. WEIR, LIMITED, engineers, have removed their Manchester office from 22, St. Mary's Gate to 44, Corporation Street, Manchester.

MR. GEO. HALL has been appointed foundry manager to Messrs. Frank Wigglesworth & Company, Limited, Clutch Works, Shipley, Yorks.

MESSRS. PRIESTMAN BROS., LIMITED, of Hull, have obtained an order from the Swedish Government for a powerful grab, to be used in work in connection with the installation of new hydro-electric power plant. The value of the contract is about £4,000.

AUGUST'S, LIMITED, was last Tuesday adopted as the name of August's Muffle Furnaces, Limited, Thorn Tree Works, Halifax. It is obviously more suited to the wide range of products now manufactured than was the restrictive title previously used.

AT AN EXTRAORDINARY GENERAL MEETING of Messrs. Ayling & Company (Brassfounders), Limited, resolutions were passed winding up the company voluntarily and authorising the liquidator, Mr. E. H. Miller, of 57-58, Chancery Lane, London, to enter into an agreement with Messrs. J. G. Wolff & Company, Limited.

MESSRS. SCOTT & SONS, Bowling, have launched a powerful sea-going screw tug of about 250 tons, which they have built for Messrs. James Dredging Towage & Transport Company, Limited. The builders will install the machinery, consisting of large triple-expansion engines constructed by the North Eastern Marine Engineering Company, Limited, Wallsend.

A MESSAGE from Nanking states that the Chinese Government has decided to buy British equipment to start extensive iron and steel works outside the capital. A site between Nanking and the Yangtze River has been selected, and building is to begin shortly. It is stated that the Government has earmarked £123,000 from the returned Boxer Indemnity for the construction of these works.

THE COMPANIES REGISTRATION OFFICE gives notice that the following companies have been dissolved and their names struck off the register:—Burdon Oil-Gas Furnaces, Limited; Devon Anthracite, Limited; Hebburn Steel Castings Company, Limited; Langdon Engineering Company (1924), Limited; Llwynonn Colliery Company, Limited; Metal & Iron Company, Limited; Ton Hir Colliery Company, Limited.

MR. DUNCAN J. SHEDDEN, of Dudley, offered for sale at Wolverhampton recently, as a going concern, the Spring Vale Foundry of Messrs. Thomas Sheldon & Company, Limited, Ettingshall, Wolverhampton, in voluntary liquidation. The sale was by order of the receiver and manager for the debenture holders. There was no bid, and the auctioneer announced that the business would be dealt with privately.

A FIRE AT THE Adelphi Ironworks, Salford, of Messrs. Sir James Farmer Norton & Company, Limited, which occurred recently, destroyed the building housing the pattern-making shops and the pattern stores. The fitting and erection shops and the machine tools were unaffected, except for slight damage to the roofs, and the administrative offices also were not touched. Operations at the works were suspended for a few days.

MESSRS. LOBNITZ & COMPANY, LIMITED, Renfrew, launched the powerful bucket and pump dredger "Belomorskaya," built to the order of Arcos, Limited, on behalf of U.S.S.R. This is the first Soviet vessel built on the Clyde, and is 197 ft. long of 1,050 tons gross. The designed speed of the vessel is 8 knots. The propelling machinery consists of three triple-expansion engines each of 600 i.h.p. The hull and machinery are being built to Lloyd's 100 A1 class.

THE BLYTHSWOOD SHIPBUILDING COMPANY, LIMITED, Scotstoun, Glasgow, have secured an order for an oil-carrying steamer, about 200 ft. long, for London owners. The machinery, consisting of single-screw triple-expansion engines and oil-fired boiler, will be supplied by Messrs. David Rowan & Company, Limited, Glasgow. The Blythswood company specialise in this type of tanker, and the present vessel is the fourth they have built for the same owners in the last few years.

MR. ANDREW M. BRYAN, B.Sc., M.I.M.E., of Newcastle-upon-Tyne, has been appointed to the James S. Dixon Chair of Mining in the University of Glasgow and the Professorship of Mining in the Royal Technical College, Glasgow. Mr. Bryan is a graduate of Glasgow, and has had experience of many phases of mining practice. Since 1926 he has been one of H.M. Senior Inspectors of Mines and Quarries in the Northern Mines Inspection Division. He has been actively associated with the Armstrong College Mining Society.

MESSRS. HARLAND & WOLFF, LIMITED, launched from their Govan yard the single-screw cargo and passenger steamer "Bhadravati," which they have built to the order of the Bombay Steam Navigation Company, Limited, Bombay, and which will be employed between Bombay and various Indian coastal ports. The vessel is 230 ft. in length with a breadth moulded of 38½ ft. Six hydraulic cranes are provided for cargo handling in lieu of the usual derricks. The propelling machinery is of the triple-expansion type, steam being provided by two single-ended Scotch boilers arranged for forced draft and coal- or oil-fuel firing.

Personal.

MR. DAVID LOFTS, Superintendent of the American Steel Foundry Company, is at present in England on vacation.

MR. STANLEY E. EVANS, late of Messrs. Swan, Hunter & Wigham Richardson, Limited, has taken up an appointment under Murex Welding Processes, Limited, as naval architect and expert on welding matters in relation to shipbuilding.

MR. T. FEARNLEY ALLEN is shortly leaving for Buenos Aires for an extended holiday. His business at Norwich Union Chambers, Birmingham, will be carried on by his son, Mr. Andrew Allen. His many friends in the foundry industry will join us in wishing him continued good health during his vacation.

MR. WALTER JAMES REES, head of the Department of Refractory Materials of the University of Sheffield, has been awarded 100 guineas from the administrators of the Sir George Beilby Memorial Fund. Mr. Rees has been engaged in research on refractory materials and their industrial application for a number of years.

SIR JAMES LITHGOW has been offered and has accepted a seat on the board of Messrs. William Beardmore & Company, Limited. Sir James Lithgow, who is chairman of Messrs. Lithgows, Limited, shipbuilders, of Port Glasgow, is also a director of Messrs. Colvilles, Limited, and James Dunlop & Company, Limited, and chairman of the National Shipbuilders' Security, Limited.

LORD RANKEILLOUR has been appointed "the first stock director" and Mr. L. S. Amery, M.P., has been appointed "the third stock director" of Messrs. Cammell, Laird & Company, Limited, Birkenhead, in accordance with the recent scheme of arrangement approved by the debenture holders and shareholders, and confirmed by the Court. Mr. A. N. Winder, of Manchester, has also been elected a director of the company.

MR. CHARLES H. KEEN has been elected a director of the British (Guest Keen Baldwins) Iron & Steel Company, Limited. Mr. Keen joined Messrs. Guest, Keen & Nettlefolds, Limited, several years ago. At present he is works manager of the Cardiff-Dowlais works of the British (Guest Keen Baldwins) Iron & Steel Company, Limited. He is a son of the late chairman of Messrs. Guest, Keen & Nettlefolds and a nephew of Mr. Frank Keen (deputy-chairman and one of the joint managing directors). He is a director of Messrs. Guest, Keen & Piggotts, Limited, and of the Orconera Iron Ore Company, Limited.

Wills.

HARVEY, GEORGE, of Sheffield, ironfounder	£8,102
SMITH, F. C., of Sutton Coldfield, brassfounder	£30,458
BRITTON, CHARLES, of Erdington, retired brassfounder	£15,530
RETALLACK, CHARLES, of Anchorage Road, Sutton Coldfield, lately managing director of John Harper & Company, Limited, Albion Works, Willenhall, ironfounders	£30,034

Obituary.

MR. WALTER MACFARLANE, one of the best-known ironfounders in the West of Scotland, died at his home in Glasgow on Sunday, July 3. In 1880 he became connected as a partner with the Saracen Foundry, Possilpark, Glasgow, and five years later became head of the firm, which now bears the name of Walter Macfarlane & Company. He was a Deputy Lieutenant of the County of the City of Glasgow, and a J.P.

MR. W. S. HILL, who has died at his home in Redcar, was for many years associated with the iron industry of the district. At the age of 23 he succeeded his father as manager of the Clay Lane Ironworks at South Bank. Seven years later he joined Messrs. Walker, Maynard & Company, and took charge of their ironworks at Warrenby. In 1904 he became a director of the firm, and in 1916, when the undertaking was purchased by Messrs. Dorman, Long & Company, and the steelworks added, Mr. Hill continued the supervision of the blast-furnace department. On his retirement a few years ago he had spent 35 years of his career as a works manager. He was an alderman of the Borough of Redcar and a member of the North Riding County Council.

British Cast Iron Research Association.

(*Concluded from page* 22.)

sion of the heartfelt gratitude we feel for the impetus which we hope the Association will derive from their presence here to-day, and the most stimulating address which has just been delivered by Lord Rutherford. He also expressed the gratitude of the Association to Sir Harold Hartley, their President, for his untiring and timely efforts on their behalf with the D.S.I.R. The manufacture of the products in which we are interested touches the community at many points, more perhaps than any other. Cast iron is ubiquitous and was in evidence in all public buildings and houses in the form of domestic castings, hollow-ware, grates and stoves, baths and radiators. It is responsible for taking supplies such as water to our cities and for the effective removal of sewage. No public utility service, power station, gasworks, waterworks, could exist without it. It comprises the bulk of our machinery in the form of hydraulic, textile, mining, automobile, agricultural, aeronautical, etc.

"It was because it touched the life of the community at so many points that the Association was glad to have as their guests representatives of such a variety of interests, of technical and scientific institutions and other bodies. In particular it gives them great pleasure to welcome the Vice-Chancellor of the University of Birmingham, to whom they were very much indebted, and to Professor Hanson, for the help and ready co-operation always at their disposal."

SIR CHARLES GRANT ROBERTSON, speaking in acknowledgment of the toast, said that he welcomed the connection between their Association and the University and particularly that Department of Metallurgy, which was presided over by his distinguished colleague, Professor Hanson.

After luncheon the company proceeded to the new laboratory, which the President Sir Harold Hartley, invited Lord Rutherford to declare open.

In doing so, Lord Rutherford said:—"He now formally declared this building open, and expressed a hope that more and even better work will be the result of this addition to the laboratory."

The visitors, in small groups, afterwards inspected the premises and equipment.

MESSRS. A. G. MUMFORD, LIMITED, is being wound up voluntarily. The liquidator is Mr. G. C. Bensusan-Butt, 8, West Stockwell Street, Colchester.

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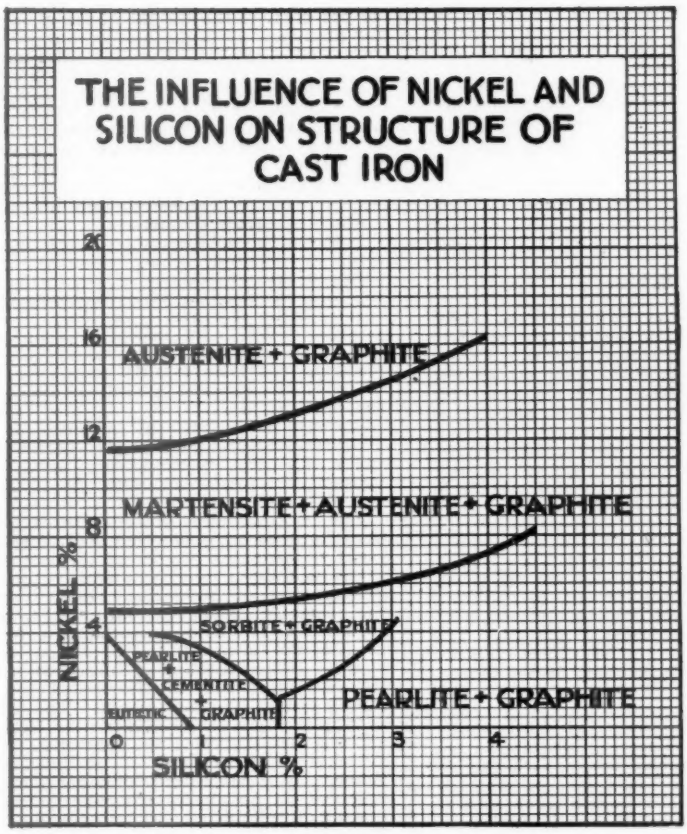
SOUNDNESS



BRADLEY'S Refined Nickel Alloy Pig Irons are specially suitable for Air Hardening, Oil Hardening, Martensitic, Austenitic and special cylinder irons.

These Nickel Alloy Irons are available with all Nickel contents from 0.5% up to 25%, for direct use or in admixture with other irons in the manufacture of various types of Nickel Cast Iron.

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Raw Material Markets.

Business remains very limited in the iron and steel markets, mainly owing to holiday influences and the fact that fairly large stocks of material are still held at many consuming works. On the other hand, the prospect of a better autumn season has helped to strengthen market sentiment, which has also been favourably influenced by the outcome of the Lausanne Conference, the initial success of the conversion loan scheme, with its promise of cheaper money for industry, and the new order prolonging the iron and steel tariff for a further three months. It is generally agreed, however, that any recovery in the consuming industries will not take place until the autumn.

Pig-Iron.

MIDDLESBROUGH.—The occurrence of the Scottish holiday season has meant the temporary closing of an important outlet for Cleveland iron, while the demand from other markets, both home and export, also remains limited. Local consumers are buying sparingly and are pressing for reduced prices, but these are not likely to be granted, as the ironmasters state that at present they are not realising their costs of production. The fixed prices are as follow:—No. 1 Cleveland foundry iron, 61s.; No. 3 Cleveland G.M.B., 58s. 6d.; No. 4 foundry, 57s. 6d.; No. 4 forge iron, 57s. per ton, f.o.t. or f.o.b.

Business is rather weak in the East Coast hematite market, and the present prices of 62s. 6d. for mixed numbers and 63s. for No. 1 quality might be shaded for a large order. It has not yet been decided when to restart the two hematite furnaces at the Ayresome Ironworks, which are now ready to resume. West Coast hematite is at present going into steady consumption at the Barrow and Workington steelworks, while there is a fair demand from the Midlands and other markets. Bessemer mixed numbers remain at 66s. per ton at works.

LANCASHIRE.—Orders for foundry iron have been mainly on the small side, but one or two large contracts have been placed by important consuming firms, whose previous agreements had run out. On the whole, a steady tonnage continues to go into consumption, in spite of the slack conditions at most of the jobbing foundries. For delivery to users in the Manchester price zone, Derbyshire and Staffordshire brands of No. 3 are quoted at 67s. per ton, with North-East Coast iron also at about this figure, Northants at 65s. 6d., Derbyshire forge iron at 62s. and Scottish pig-iron at from 84s. 6d. to 85s. 6d.

MIDLANDS.—A fair number of orders has been taken during the past week, but transactions continue to be mostly of a small nature. Many large consumers would be seeking for contract renewals now, were industry in its normal condition. Prices are unchanged, present quotations, delivered Birmingham and Black Country stations, being as follow:—Northamptonshire foundry, No. 3, 62s. 6d.; No. 1, 65s. 6d.; forge, 57s. 6d.; Derbyshire, No. 3, 66s.; No. 1 foundry, 69s.; forge, 61s. North Staffordshire and Lincolnshire iron is obtainable at the same price as Derbyshire pig. Cleveland No. 3 is at 66s. delivered Midland stations.

SCOTLAND.—The Glasgow foundries will be closing down this week for the holidays, and in many cases will not reopen for a fortnight. Hence business is very slack in that district, while little has been done in the Falkirk area, and for the same reason. The weekly shipments of pig-iron from the Clyde are at a very low ebb indeed. Scottish foundry iron No. 3 remains at 69s. 6d., f.o.t. furnaces, with a minimum of 2s. 6d. extra for No. 1. No. 3 Middlesbrough is at 55s. 6d., f.o.t. Falkirk.

Coke.

Furnace and foundry cokes continue to be a slow market, owing to the depression prevailing in the iron and steel industries. Quotations, delivered Birmingham and district, are:—Best Durham foundry coke, 37s. 6d.; other grades, 35s.; Welsh foundry, 30s. to 45s., according to analysis and tonnage.

Steel.

Conditions are very irregular throughout the finished-steel works. The plate and section mills are mostly in need of work, except in one or two cases, owing to the bad state of trade at the consuming works. Tinplates remain steady, but there is little demand for galvanised sheets. The semis market is still dominated by cheap offers from the foreign producers, who are, however, getting little business. Trade in general remains limited, but the home works are getting a larger share of the orders.

Scrap.

Conditions remain unchanged in the Cleveland scrap-iron market, the demand being very limited. Ordinary metal is at 35s. per ton, machinery quality at 36s. and light castings at 32s. In the Midlands, no improvement can be reported in the market for cast-iron scrap, most of the local ironfounders being quiet and only purchasing their requirements of cast-iron scrap on a hand-to-mouth basis. Good heavy machinery, broken into suitable cupola sizes, is offered at 45s. per ton delivered, heavy pipe and plate at 40s. per ton delivered and clean light at 35s. per ton delivered. Little business is being done in Scotland and prices are weak and largely nominal. Very similar conditions prevail in the South Wales market, where heavy cast iron in large pieces and foundry sizes is weak at 38s. to 40s.

Metals.

Copper.—In spite of minor fluctuations, caused by professional buying and selling, the standard market remains fairly steady at bottom. Reports have been received, both from home sources and several parts of the Continent, of an increase in inquiries from consumers, many of whom have allowed their stocks to run to a very low level indeed. On the other hand, keen competition prevails in the European market between the now dis-associated producers, and it is still possible to buy metal at 5 cents c.i.f. Europe, or even less in one or two directions.

Closing quotations :—

Cash.—Thursday, £27 2s. 6d. to £27 5s.; Friday, £26 18s. 9d. to £27 1s. 3d.; Monday, £26 17s. 6d. to £26 18s. 9d.; Tuesday, £26 12s. 6d. to £26 15s.; Wednesday, £26 7s. 6d. to £26 10s.

Three Months. — Thursday, £26 15s. to £26 17s. 6d.; Friday, £26 11s. 3d. to £26 12s. 6d.; Monday, £26 7s. 6d. to £26 8s. 9d.; Tuesday, £26 7s. 6d. to £26 10s.; Wednesday, £25 17s. 6d. to £26.

Tin.—Standard tin has remained fairly steady during the past week. The news from abroad has been mainly of a favourable nature, including reports of a small increase in buying in America. There are rumours of the formation of a large pool to take up cash tin, and, if there is any foundation for them, there is likely to be a considerable hardening of the spot position when the pool begins operations.

Official closing prices :—

Cash.—Thursday, £127 10s. to £127 15s.; Friday, £126 10s. to £126 15s.; Monday, £124 15s. to £125; Tuesday, £125 15s. to £126; Wednesday, £126 12s. 6d. to £126 17s. 6d.

Three Months.—Thursday, £128 15s. to £129; Friday, £128 5s. to £128 7s. 6d.; Monday, £126 5s. to £126 10s.; Tuesday, £127 10s. to £127 15s.; Wednesday, £128 to £128 5s.

Spelter.—Although the galvanising industry in this country has complained of a poor trade for some months, there has recently been quite a fair spurt in buying of zinc, mainly on account of stock replacements. The Lausanne Conference may mark the beginning of a recovery in Continental industries and in the Continental consumption of spelter, which has been very poor of late.

Daily fluctuations :—

Ordinary. — Thursday, £11 11s. 3d.; Friday, £11 16s. 3d.; Monday, £11 11s. 3d.; Tuesday, £11 11s. 3d.; Wednesday, £11 7s. 6d.

Lead.—There has been some small buying by consumers, and the tone of the market is fairly cheerful. Lower quotations are now available in the American market, but the decrease is not general, and some recovery in buying is looked for in several influential quarters.

The week's prices have been :—

Soft Foreign (Prompt).—Thursday, £10 1s. 3d.; Friday, £10 1s. 3d.; Monday, £10 5s.; Tuesday, £10 3s. 9d.; Wednesday, £9 16s. 3d.

Students' Corner.

(*Continued from page* 392, Vol. 46.)

Q.—Are there in existence furnaces capable of competing with the cupola?

ANSWER CONTINUED.

The approximate times given for the various operations with a 5-ton charge are :—Charging, 5 to 10 min.; melting from charging to tapping: malleable iron, 2¼ to 3 hrs.; grey iron, 2¼ to 2¾ hrs.

With ordinary pig-iron, the consumption of coal dust can be taken as 15 to 20 per cent. of the weight of the charge for malleable castings (casting temperature 1,500 deg. C.). For grey cast iron about 12 to 16 per cent. (casting temperature 1,400 deg. C.). The rotary movement, it is claimed, has the effect of thoroughly mixing the charge which is evenly and uniformly heated throughout. That the bath of molten metal does not come into direct contact with the flame, which prevents oxidation, and no gas is introduced into the metal.

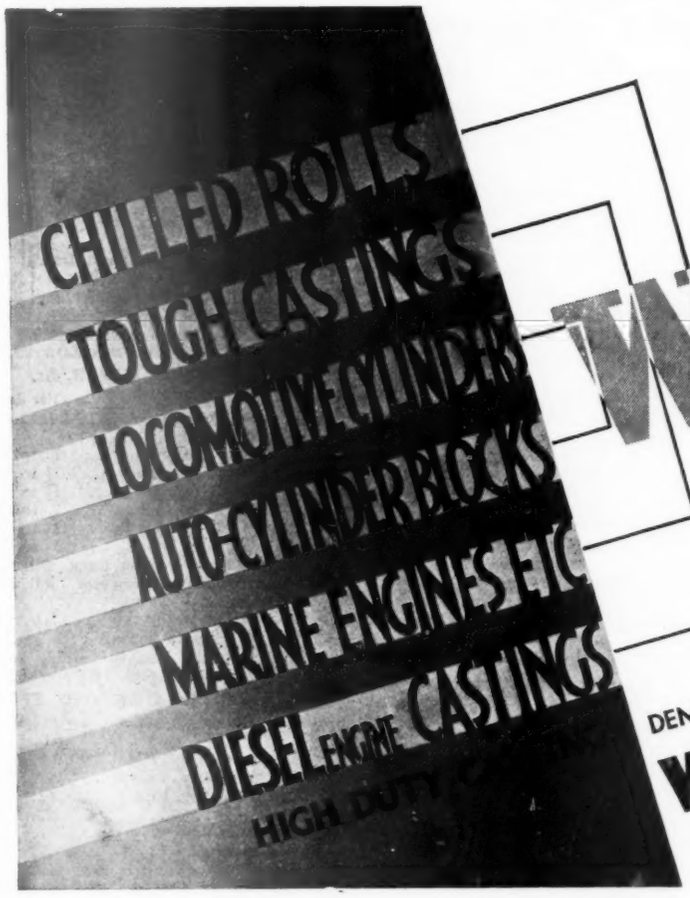
It is also stated that due to low oxidation, or burning (under 1 per cent.), it is possible when charging the furnace to predetermine the analysis and the mechanical properties of the final product. The metallurgical advantages are :—Gas-free iron, fine-grained close texture, consistency in the composition of the fluid material (physical properties unequalled).

Taking all sources of expense into consideration, the cost of good castings made by the Brackelsberg furnace process is comparable with the latest type of cupola.

The Sesci furnace, like the Brackelsberg, is fired by pulverised coal. The plant required for the Sesci furnace is given as follows :—(1) The storage and preparation of pulverised fuel; (2) the furnace proper; (3) the heat recuperator; (4) the mechanism for rotating the furnace; and (5) the control board. When melting is in operation, the pulverised fuel is distributed into piping heated by waste gases. The air is supplied by a volumetric blower, both air and fuel deliveries are controlled by variable-speed motors. The furnace consists of a steel-built cylinder, and revolved by means of two roller paths resting on rolls fitted with ball bearings. The lining is composed of a special refractory, which is rammed against the steel shell. To do this, the furnace body is put in a vertical position by means of cranes or special equipment. The blower is fixed to the furnace and rotates with it when in operation. At the opposite end of the furnace is situated a steel structure which is the movable exhaust box, mounted on a bogie suitably lined which allows the hot gases to pass from the furnace into the flues for further utilisation. This bogie is controlled by an electric motor, hence the charging end of the furnace can be uncovered quickly. The hot gases are sent into the flue through the exhaust box towards the recuperator.

The recuperator reintroduces in the furnace roughly 30 per cent. of the calorific power of the fuel utilised. The rotation mechanism is controlled by means of a variable-speed motor with reduction gear and chain drive. The movement is regulated from a gentle oscillation at slow speed while the charge is cold to a full revolution in either direction as melting proceeds. Thus the metal comes in contact with the hottest part of the lining accelerating the melting and saving the lining.

(*To be continued.*)



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WARNER & CO., LIMITED.

CARGO FLEET · MIDDLESBROUGH.

CAST IRON FLANGED PIPES

2 in.—12 in. & CONNECTIONS. to 24 in. dia.

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WEEKLY PRICE CURRENT.

COPPER.

	£ s. d.
Standard cash	26 7 6
Three months	25 17 6
Electrolytic	29 10 0
Tough	28 10 0
Best selected	29 0 0
Sheets	59 0 0
India	40 0 0
Wire bars	31 0 0
Do., Aug.	31 0 0
Do., Sept.	31 0 0
Ingot bars	31 0 0
H.C. wire rods	34 0 0
Off. av. cash, June	26 18 4 2/5
Do., 3 mths., June	26 14 8 1/4
Do., Sttlmnt., June	26 18 7 7/11
Do., Electro, June	31 5 2 6/11
Do., B.S., June	30 4 4 1/2
Do., wire bars, June	31 13 7 7/11
Solid drawn tubes	9 1/2d.
Brazed tubes	9 1/2d.
Wire	6 1/2d.

BRASS.

Solid drawn tubes	9d.
Brazed tubes	11d.
Rods, drawn	7 1/2d.
Rods, extd. or rlld.	4 1/2d.
Sheets to 10 w.g.	7 1/2d.
Wire	7 1/2d.
Rolled metal	6 1/2d.
Yellow metal rods	4d.
Do. 4 × 4 Squares	5 1/2d.
Do. 4 × 3 Sheets	5 1/2d.

TIN.

	£ s. d.
Standard cash	126 12 6
Three months	128 0 0
English	128 5 0
Bars	129 10 0
Straits	130 15 0
Australian	128 15 0
Eastern	131 10 0
Banca	135 15 0
Off. av. cash, June	114 12 11
Do., 3 mths., June	116 18 5 3/7
Do., Sttlmt., June	114 13 1 1/7

SPELTER.

	£ s. d.
Ordinary	11 7 6
Remelted	10 10 0
Hard	9 5 0
Electro 99.9	14 0 0
English	12 12 6
India	11 5 0
Zinc dust	19 0 0
Zinc ashes	1 15 0
Off. aver., June	11 14 1 17/28
Aver. spot, June	11 10 11 15/28

LEAD.

	£ s. d.
Soft foreign ppt.	9 16 3
Empire	10 17 6
English	11 15 0
Off. average, June	9 15 0 1/35
Average spot, June	9 12 1 10/11

ZINC SHEETS, &c.

	£ s. d.
Zinc sheets, English	22 10 0
Do., V.M. ex-whf.	20 0 0
Rods	26 0 0
Boiler plates	—
Battery plates	—

ANTIMONY.

	£ s. d.
English	35 0 0 to 42 10 0
Chinese	22 10 0
Crude	16 0 0

QUICKSILVER.

	£ s. d.
Quicksilver	10 15 0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
25%	8 5 0
45/50%	13 5 0
75%	19 0 0
Ferro-vanadium—	
35/50%	12/8 lb. Va
Ferro-molybdenum—	
70/75% c. free, of Mo.	6/3 per lb.
Ferro-titanium—	
23/25% carbon-free	11d. lb.
Ferro-phosphorus, 20/25%	£21 0 0
Ferro-tungsten—	
80/85%	2/- lb.
Tungsten metal powder—	
98/99%	2/3 1/2 lb.
Ferro-chrome—	
2/4% car.	£27 15 0
4/6% car.	£25 0 0
6/8% car.	£24 10 0
8/10% car.	£23 15 0
Ferro-chrome—	
Max. 2% car.	£37 0 0
Max. 1% car.	£46 17 6
Max. 0.70% car.	£48 5 0
70% carbon-free	1/1 lb.
Nickel—80/99.5%	£230 to £235
"F" nickel shot	£207 0 0
Ferro-cobalt	8/- lb.
Aluminium 98/99%	£95 0 0
Metallic chromium—	
96/98%	2/9 lb.
Ferro-manganese (net)—	
76/80% loose	£10 15 0 to £11 5 0
76/80% packed	£11 15 0 to £12 5 0
76/80% export	(nom.) £9 0 0
Metallic manganese—	
94/96% carbon-free	1/4 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	2s. 0d.
Finished bars, 18% tungsten	2s. 9d.

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under 1/2 in. to 1/4 in.	3d. lb.
Do., under 1/4 in. to 3/16 in.	1/- lb.
Flats, 1/2 in. × 1/4 in. to under 1 in. × 1/8 in.	3d. lb.
Do., under 1/4 in. × 1/4 in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP.

	£ s. d.	£ s. d.
South Wales—		
Heavy steel	1 17 6	
Bundled steel and shrngs.	1 14 0	to 1 17 0
Mixed iron and steel	1 15 0	to 1 16 0
Heavy cast iron	1 18 0	to 2 0 0
Cleveland—		
Heavy steel	1 15 0	
Steel turnings	1 10 0	
Cast-iron borings	1 2 6	
Heavy forge	2 10 0	
W.I. piling scrap	2 2 6	
Cast-iron scrap	1 15 0	to 1 16 0
Midlands—		
Light cast-iron scrap	1 15 0	
Heavy wrought iron	2 7 6	
Steel turnings, f.o.r.	0 18 6	
Scotland—		
Heavy steel	1 15 0	
Ordinary cast iron	2 0 0	
Engineers' turnings	1 8 0	
Cast-iron borings	1 10 0	
Wrought-iron piling	1 18 6	
Heavy machinery	2 5 0	

London—Merchants' buying prices delivered yard.

	£ s. d.
Copper (clean)	22 0 0
Brass	13 0 0
Lead (less usual draft)	7 0 0
Tea lead	5 0 0
Zinc	5 10 0
New aluminium cuttings	72 0 0
Brassiery copper	18 0 0
Gunmetal	17 0 0
Hollow pewter	70 0 0
Shaped black pewter	50 0 0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	61/-
Foundry No. 3	58/6
Foundry No. 4	57/6
Forge No. 4	57/-
Hematite No. 1	63/-
Hematite M/Nos.	62/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	72/-
" d/d Birm.	84/6
Malleable iron d/d Birm.	117/6
Midlands—	
Staffs common*	—
" No. 4 forge*	61/-
" No. 3 fdry.*	66/-
Shrops basic	—
" Cold blast, ord.	—
" " roll iron	—
Northants forge*	57/6
" fdry. No. 3*	62/6
" fdry. No. 1*	65/6
Derbyshire forge*	61/-
" fdry. No. 3*	66/-
" fdry. No. 1*	69/-
" basic*	—

*d/d Black Country dist.

Scotland—	
Foundry No. 1	72/-
" No. 3	69/6
Hem. M/Nos. d/d	68/6
Sheffield (d/d district)—	
Derby forge	58/6
" fdry. No. 3	63/6
Lincs forge	—
" fdry. No. 3	63/6
E.C. hematite	74/6
W.C. hematite	83/6
Lancashire (d/d eq. Man.)—	
Derby forge	62/-
" fdry. No. 3	67/-
Staffs fdry. No. 3	67/-
Northants fdry. No. 3	65/6
Cleveland fdry. No. 3	67/-
Dalzell, No. 3 (special)	102/6 to 105/-
Glengarnock, No. 3	84/6 to 85/6
Clyde, No. 3	84/6 to 85/6
Monkland, No. 3	84/6 to 85/6
Summerlee, No. 3	84/6 to 85/6
Eglinton, No. 3	84/6 to 85/6
Gartsherrie, No. 3	84/6 to 85/6
Shotts, No. 3	84/6 to 85/6

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

	£ s. d.	£ s. d.
Iron—		
Bars (cr.)	9 5 0	to 9 15 0
Nut and bolt iron	7 15 0	to 8 10 0
Hoops	10 10 0	to 12 0 0
Marked bars (Staffs) f.o.t.	12 0 0	
Gas strip	10 10 0	to 12 0 0
Bolts and nuts, 1/4 in. × 4 in.	12 0 0	
Steel—		
Plates, ship, etc.	8 15 0	to 8 17 6
Boiler plts.	8 7 6	to 9 5 0
Chequer plts.	10 7 6	
Angles	8 7 6	
Tees	9 7 6	
Joists	8 15 0	
Rounds and squares, 3 in. to 5 1/2 in.	9 7 6	
Rounds under 3 in. to 1/4 in. (Untested)	6 12 6	& up.
Flats—8 in. wide and over	8 12 6	
" under 8 in. and over 5 in.	8 17 6	
Rails, heavy	8 5 0	to 8 10 0
Fishplates	12 0 0	
Hoops (Staffs)	9 10 0	
Black sheets, 24g.	8 0 0	to 8 10 0
Galv. cor. shts.	9 5 0	to 10 0 0
Galv. flat shts.	9 15 0	to 11 0 0
Galv. fencing wire, 8g. plain	12 7 6	
Billets, soft	4 17 6	to 5 7 6
Billets, hard	6 12 6	
Sheet bars	4 15 0	to 5 5 0
Tin bars	4 15 0	

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	10 1/2d.
Sheet to 10 w.g.	11 1/2d.
Wire	11 1/2d.
Rods	10 1/2d.
Tubes	16d.
Castings	12d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1 1/2 to 1/7 1/2
To 15 in. wide	1/1 1/2 to 1/7 1/2
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2 1/2 to 1/8 1/2
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3 1/2
Ingots rolled to spoon size	10d. to 1/6 1/2
Wire round—	
to 10g.	1/4 1/2 to 1/11 1/2

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3 1/2 upwards.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	14.84
No. 2 foundry, Valley	14.50
No. 2 foundry, Birm.	11.00
Basic	15.89
Bessemer	16.89
Malleable	16.89
Grey forge	16.39
Ferro-mang. 80%, seaboard	68.00
O.-h. rails, h'y, at mill	43.00
Billets	27.00
Sheet bars	26.00
Wire rods	37.00
	Cents.
Iron bars, Phila.	2.11
Steel bars	1.60
Tank plates	1.60
Beams, etc.	1.60
Skelp, grooved steel	1.60
Skelp, sheared steel	1.60
Steel hoops	1.65
Sheets, black, No. 24	2.20
Sheets, galv., No. 24	2.85
Wire nails	1.95
Plain wire	2.20
Barbed wire, galv.	2.60
Tinplates, 100-lb. box	$4.75

COKE (at ovens).

Welsh foundry	20/- to 25/-
" furnace	16/- to 16/6
Durham and Northumberland—	
" foundry	21/- to 25/-
" furnace	13/- to 13/6
Midlands, foundry	—
" furnace	—

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. cokes 20×14 per box	14/9 to 15/3
" 28×20 "	29/6 to 30/6
" 20×10 "	—
" 18 1/2×14 "	—
C.W. 20×14 "	—
" 28×20 "	—
" 20×10 "	—
" 18 1/2×14 "	—

SWEDISH CHARCOAL IRON & STEEL.

	£ s. d.	£ s. d.
Pig-iron	£6 0 0	to £7 0 0
Bars, hammered, basis	£16 10 0	to £17 0 0
Bars and nail-rods, rolled, basis	£15 17 6	to £16 5 0
Blooms	£10 0 0	to £12 0 0
Keg steel	£32 0 0	to £33 0 0
Faggot steel	£18 0 0	to £23 0 0
Bars and rods dead soft, at'l	£10 0 0	to £12 0 0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 18.16 to £1.]

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.		
July	7 ..	27	2	6	dec.	2/6
„	8 ..	26	18	9	„	3/9
„	11 ..	26	17	6	„	1/3
„	12 ..	26	12	6	„	5/-
„	13 ..	26	7	6	„	5/-

Electrolytic Copper.

		£	s.	d.		
July	7 ..	31	0	0	inc.	10/-
„	8 ..	30	0	0	dec.	20/-
„	11 ..	30	10	0	inc.	10/-
„	12 ..	30	10	0	No change	
„	13 ..	29	10	0	dec.	20/-

Standard Tin (cash).

		£	s.	d.		
July	7 ..	127	10	0	inc.	70/-
„	8 ..	126	10	0	dec.	20/-
„	11 ..	124	15	0	„	35/-
„	12 ..	125	15	0	inc.	20/-
„	13 ..	126	12	6	„	17/6

Tin (English ingots).

		£	s.	d.		
July	7 ..	129	10	0	inc.	80/-
„	8 ..	128	5	0	dec.	15/-
„	11 ..	126	15	0	„	30/-
„	12 ..	127	10	0	inc.	15/-
„	13 ..	128	5	0	„	15/-

Spelter (ordinary).

		£	s.	d.		
July	7 ..	11	11	3	dec.	2/6
„	8 ..	11	16	3	inc.	5/-
„	11 ..	11	11	3	dec.	5/-
„	12 ..	11	11	3	No change	
„	13 ..	11	7	6	dec.	3/9

Spelter (Electro, 99.9 per cent.).

		£	s.	d.		
July	7 ..	14	0	0	dec.	5/-
„	8 ..	14	5	0	inc.	5/-
„	11 ..	14	0	0	dec.	5/-
„	12 ..	14	0	0	No change	
„	13 ..	14	0	0	„	„

Zinc Shee's (English).

		£	s.	d.		
July	7 ..	22	10	0	No change	
„	8 ..	22	10	0	„	„
„	11 ..	22	10	0	„	„
„	12 ..	22	10	0	„	„
„	13 ..	22	10	0	„	„

Lead (English).

		£	s.	d.		
July	7 ..	12	0	0	No change	
„	8 ..	12	0	0	„	„
„	11 ..	12	0	0	„	„
„	12 ..	12	0	0	„	„
„	13 ..	11	15	0	dec.	5/-

Imports and Exports of Iron and Steel Castings in June and the six months 1932, compared with June and the six months 1931.

	June, 1931.	June, 1932.	Six months, 1931.	Six months, 1932.	June, 1931.	June, 1932.	Six months, 1931.	Six months, 1932.
Imports.	Tons.	Tons.	Tons.	Tons.	£	£	£	£
Pipes and Fittings, Cast	1,004	274	6,490	1,715	11,980	4,953	84,284	30,340
Castings, in the Rough, Iron	111	44	900	524	2,058	869	18,261	9,267
„ „ „ Steel	294	141	3,145	1,045	6,337	2,106	67,149	20,076
Hollow-ware, Cast, not Enamelled	10	2	38	7	671	222	2,704	653
„ „ Enamelled	1	7	37	55	83	239	1,713	1,870
Exports.								
BUILDERS' CASTINGS—								
To Argentine Republic	96	12	488	227	4,838	609	21,562	8,443
„ Irish Free State	373	441	1,951	2,160	16,753	19,635	94,007	96,417
„ British South Africa	174	85	960	806	7,019	3,200	38,074	28,843
„ „ India	109	74	723	484	3,923	2,083	25,089	16,724
„ New Zealand	21	27	235	139	1,081	1,045	14,518	7,131
Total (including other countries)	1,090	924	6,430	5,896	48,060	39,649	288,480	244,678
PIPES AND FITTINGS—CAST—								
To Argentine Republic	295	87	3,383	1,131	3,129	1,070	32,620	12,183
„ Irish Free State	1,628	457	6,716	3,981	16,907	5,859	75,834	54,800
„ British South Africa	368	210	4,677	2,580	3,401	3,275	54,229	31,903
„ „ India	74	70	854	608	1,056	1,452	15,182	9,877
„ Straits Settlements and Malay States	80	192	901	1,460	1,262	2,054	12,397	14,846
Total (including other countries)	5,070	5,405	37,076	35,362	54,462	59,664	423,555	367,083
HOLLOW-WARE—								
Cast, not Enamelled, and Cast, Tinned	165	206	1,154	1,206	5,403	7,933	39,763	43,502
„ Enamelled	54	44	270	397	4,327	4,458	26,808	33,831
CASTINGS, in the rough—								
Iron	414	130	1,177	505	6,209	4,410	29,571	19,486
Steel	75	45	730	431	3,168	2,667	24,953	18,476

WILLIAM JACKS & COMPANY,
WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

CLARENCE CHAMBERS, 39, CORPORATION STREET, BIRMINGHAM.
13, RUMFORD STREET, LIVERPOOL.

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IRON

All grades FOUNDRY, HEMATITE, BASIC, SPECIALS, &c.

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COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM JACKS & COMPANY,
CENTRAL CHAMBERS, 93, HOPE ST., GLASGOW, C.2.
ZETLAND ROAD, MIDDLESBROUGH.

SMALL ADVERTISEMENTS.

Notice.

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(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED.

FOUNDRY Foreman desires position; thorough knowledge all branches iron and non-ferrous; up to date on cupola and mixing metals by analysis; can guarantee results.—Box 218, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

YOUNG Man (23) desires post, Home or abroad; Higher National Cert. (3 Distinctions); 5 years' foundry experience; steam engines, turbines, machine-moulding, light castings; 3 years' D.O. experience. Salary secondary consideration.—Box 222, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

WANTED, Midlands, experienced Foundry Foreman, for jobbing work in cast iron and semi-steel. Must be willing help on floor when necessary.—Box 224, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

EMPLOYMENT REGISTER.

Conducted by the Institute of British Foundrymen by courtesy of the proprietors of THE FOUNDRY TRADE JOURNAL.

Correspondence should be addressed to the General Secretary, Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester, from whom full particulars can be obtained of this service.

Any employer wishing to communicate with a candidate should write to the General Secretary, quoting identification number.

EXPERIENCED Foundry Manager, 15 years in charge of well-known foundries doing highest-class iron and non-ferrous castings, requires position. Latest position complete control, works and commercial. Exceptional experience special irons, including Perlit. (180)

FOUNDRY Foreman, age 39, requires position; 16 years' experience in charge of foundries. Cast-iron, semi-steel, aluminium and all non-ferrous alloys, also repetition work and light castings. (181)

POSITION required as Foundry Manager or Head Foreman. First-class experience in iron and non-ferrous foundries. Machine moulding, die casting, special irons. Young. Excellent references. (182)

METALLURGIST, with first-class steelworks and foundry experience, requires position. Ten years in full charge. Cupola control, metal mixings for high-class castings. (183)

MECHANICAL Engineer, age 36, with exceptional experience in work organisation, including works manager's position, requires appointment. Has initiated planning, costing, bonus schemes, in machine shops and foundries with well-known firms. Latest position works manager. Honours Degree. Excellent war record. (184)

PROGRESSIVE Position required, either inside or outside foundry, by young man, age 33 years. Has had practical experience in jobbing foundry, and has studied the economic production of iron castings and ingot moulds. Is willing to invest small amount of capital in right concern. (185)

FOUNDRY Manager with wide experience, sound technical training, excellent credentials, is desirous of similar position. (186)

PROPERTY.

MAGNIFICENT

11 ACRES WORKS SITE.

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145,000 Sq. Ft. of Shops.

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with L.M. & S. and L. & N.E. Rlys.

WELL-BUILT & COMMODIOUS OFFICES

Will Sell whole or in lots to suit customers or Let on favourable terms. Unique opportunity for Manufacturers.

Apply—

THOS. W. WARD, LTD.,

ALBION WORKS, SHEFFIELD.

HENDON DISTRICT.—Engineers moving North have for disposal Modern Foundry, fully equipped and ready to start. Ample room for extension. Machine shop. Low price for quick sale.—Box 226, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

PATENT.

THE Proprietors of Patent No. 226751, for Improvements in or relating to Processes for Incorporating Manganese with Iron, are desirous of entering into arrangements by way of licence and otherwise on reasonable terms for purpose of exploiting same and ensuring its full development and practical working in this country.—All communications should be addressed in the first instance to Haseltine, Lake & Company, 28, Southampton Buildings, Chancery Lane, London, W.C.2.

PUBLICATION.

RYLAND'S DIRECTORY of the Coal, Iron, Steel, Tinplate, Metal, Engineering, Hardware and Allied Trades. 1932 edition. Now ready. Price 42s., bound in cloth.—INDUSTRIAL NEWSPAPERS, LTD., 49, Wellington Street, Strand, London, W.C.2.

MACHINERY.

MODERN AUTOMATICALLY-WORKING COOLING (MECHANICAL) HOT BANK, on account of plant shutting down, hardly used, complete with electric drive and appertaining shears, for Sale, cheap.—Please reply to R.K. 1150, c/o ALA HAASENSTEIN & VOGLER, Cologne (Rhine).

FOUNDRY Plant and Machinery for Sale, including: 15-, 7½- and 5-ton Overhead Electric Travelling Cranes; 10-ton Smith Loco. Steam Travelling Crane; Sand Slinger; Pneulec Royer Sand Mixing Machine; Moulding Machines; Weighing Machines; 5-ft. Pan Mills; 4- and 8-ton Cupolas; Blackman Blowing Fans; Ladles, Portable Drying Stoves; Air Compressor, 8 in. x 9 in.; Pneumatic Tools; Woodworking Machines; Drilling Machine; Lathes and Planing Machine, etc. Also other usual Foundry Plant.—Apply for full and further particulars to JAMES W. ELLIS & COMPANY, LIMITED, 9, Ellison Place, Newcastle-upon-Tyne.1.

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100 cub. ft. Port. Petrol D. Air Compressor, 100 lbs. press.

55 cub. ft. Port. Petrol D. Air Compressor, 100 lbs. press.

STEEL BUILDING, 37′ long. x 19′ x 19′ 6″ high.

30,000′ 2″ dia. S. & S. Water Quality PIPING.

ALBION WORKS, SHEFFIELD.

'Grams: Forward, Sheffield. 'Phone, 23001 (10 lines.)

"Albion" Catalogue on application.

MACHINERY—*Continued.*

FOR Sale.—One Endless Chain Core Drying Oven, 9 ft. wide, 43 ft. long, 6 ft. high, with 28 5-tier Carriers, 2-ft. x 5-ft. Trays. Equipped with gas-fired surface combustors. Load and delivery one end. Variable-speed Conveyor.—Apply, MORRIS MOTORS, LIMITED, Coventry.

'Phone: 287 SLOUGH

LADLES—GEARED

12-Ton	"Stevenson"	£48
9-Ton	"MacNeil"	£42
4-Ton	"Evans"	£28
3-Ton	"Evans"	£24
2-Ton	"Evans"	£19

PNEUMATIC MACHINES

18″×18″ Tabor split pattern	£45
30″×40″ Tabor rollover ...	£160
No. 2 Britannia Jolters	... 2 @ £36
No. 0 Britannia Jolters	... 4 @ £20
Core Jolters, 3″ Cylinder new,	£4 each

ABOVE ARE AS NEW.

BUY FROM ME AND SAVE MONEY!

ALEX. HAMMOND, *Foundry Machinery Merchant,*

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To Engineers, Founders, Manufacturers. Fine site of nearly 3 acres on Arterial Road with Foundry and Workshops and own Rail Sidings into premises. Modern Offices, Warehouse and Workrooms. Central Heating.

CHARLES A. TRICKS & SON, Auctioneers, ST. NICHOLAS STREET, BRISTOL.

PETER—WITH ONE EXCEPTION

With one exception Peter is an ordinary little fellow. Chubby, likeable, just five-and-a-half, full of life and fun, and on occasions—be it admitted—of naughtiness. Just now Peter's rather important, for this is his first term at school, and he's grappling with the intricacies of "A B C" and "Twice-Two": difficult subjects to all men of five-and-a-half, but even more difficult in Peter's case because—bad luck—he's totally blind. That's his One Exception. Peter learns reading, writing, and 'rithmetic through the medium of "Braille"—dull stuff compared with the coloured picture books of most five-and-a-halfs. However, he's a stout lad is Peter, and he's making great progress.

Would you like to know more about him? How, in spite of his "One Exception," he is being educated and, when older, technically trained and usefully employed.

There is a long waiting list of "Peters" throughout the British Isles, for whom training and accommodation must be provided in the immediate future.

Will you help with a donation or annual subscription? Any sum, large or small, will be gratefully received.

Here's a suggestion. Your eyesight is worth 3d. a year to you. Send Peter and his handicapped pals 3d. for every year you've had it. Now, please, in case it slips your memory. Good idea?

The Chairman,

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(FOUNDED 1866)

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